Antenna Boosters for IoT Devices
物联网设备的天线增强器

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April 2, 2019
Beijing, China

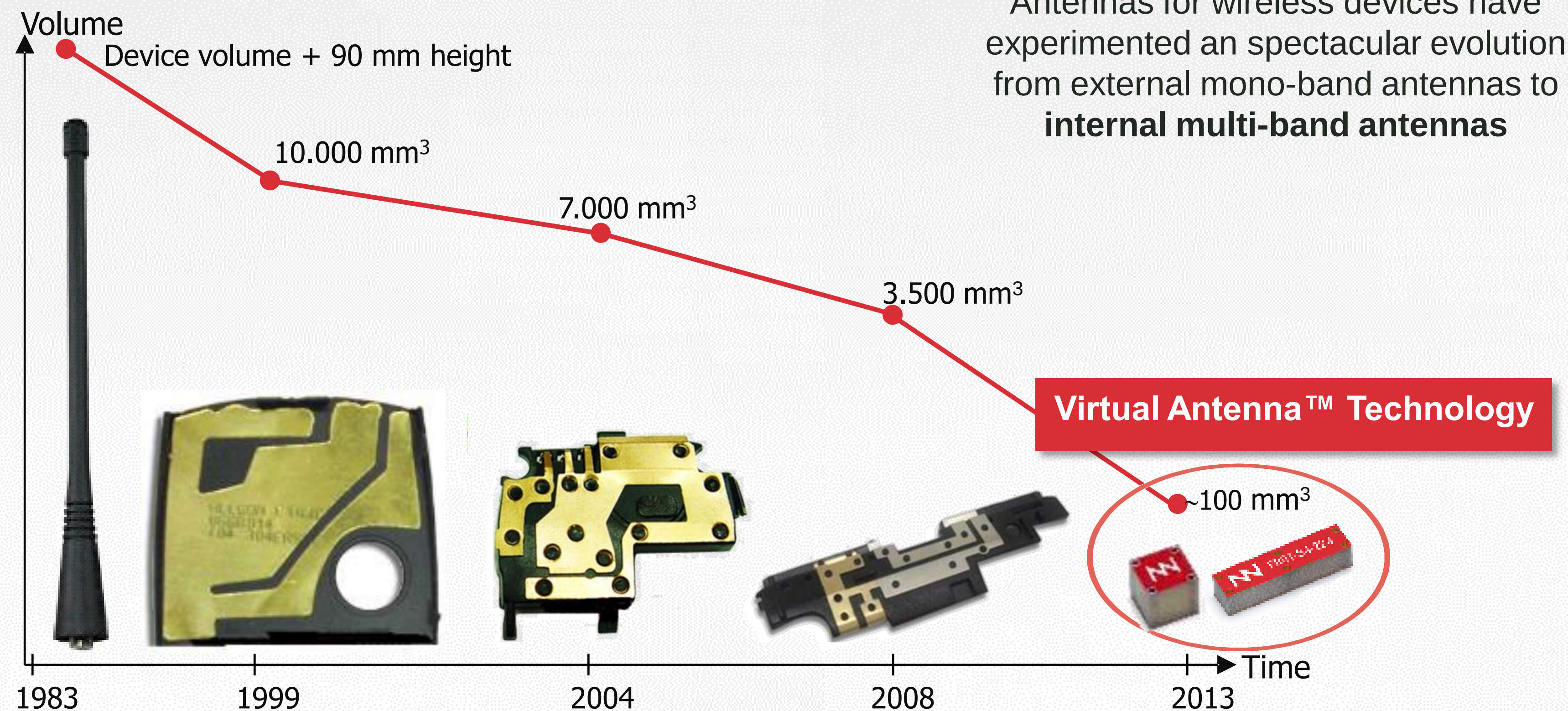
Virtual Antenna™

One antenna.
Any band.
Any device.

Faster, Cheaper, Easier.

Antenna Design Evolution

Antennas for wireless devices have experimented an spectacular evolution from external mono-band antennas to **internal multi-band antennas**

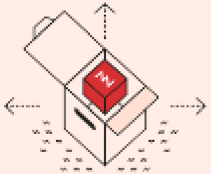


External | Internal

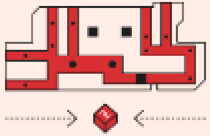
Resonant | Non - resonant

J. Anguera, A. Andújar, and C. Puente, "Antenna-Less Wireless: A Marriage Between Antenna and Microwave Engineering", Microwave Journal (invited paper), vol.60, no.10, October 2017, pp.22-36

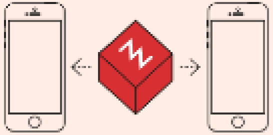
Virtual Antenna™ Technology



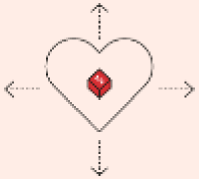
Off-the-shelf
Ready to be delivered 'as is' with no need for customization.



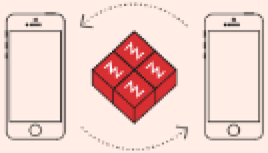
Up to 10 times smaller
A booster can be $5^3 mm^3$ providing the same connectivity.



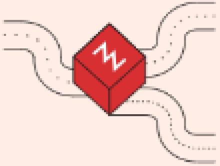
Versatility
A phone can be designed with several architectures yet still using the same component.



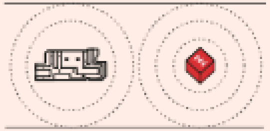
Scalability
The 'heart' of the design can be reused across multiple device models.



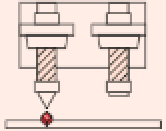
Modular
Modules or standard building blocks can be reused in the design of multiple devices.



Multiband
A single antenna provides connectivity in 2G, 3G and 4G band.



Full performance
The same performance in a much smaller, off-the-shelf and versatile component.



Pick & place
No manual assembly is needed, only a conventional SMT machine.

Virtual Antenna™ Technology

The appearance of **new mobile bands** and **smart antenna technologies**, such as **LTE** and **MIMO**, adds additional challenges to the integration of conventional antenna solutions inside handset platforms:

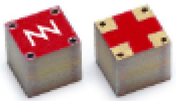
Increased number of mobile antennas inside the handset platform and interaction with other antennas such as those intended for **Wi-Fi** and **GPS**.

Additional frequency bands for new **4G and 5G standards**.

More discrete **RF front-end components**, such as matching networks, multiplexers, power amplifiers, quad-core processors, etc.

Handset platforms with **strict constraints** in terms of **size**, **weight**, **height**, **energy consumption**, **etc**.

FRACTUS ANTENNAS

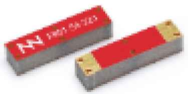


FR01-S4-250

5.0 mm x 5.0 mm x 5.0 mm

FR01-S4-232

10.0 mm x 3.2 mm x 3.2 mm



FR01-S4-224

12.0 mm x 3.0 mm x 2.4 mm

FR01-S4-220

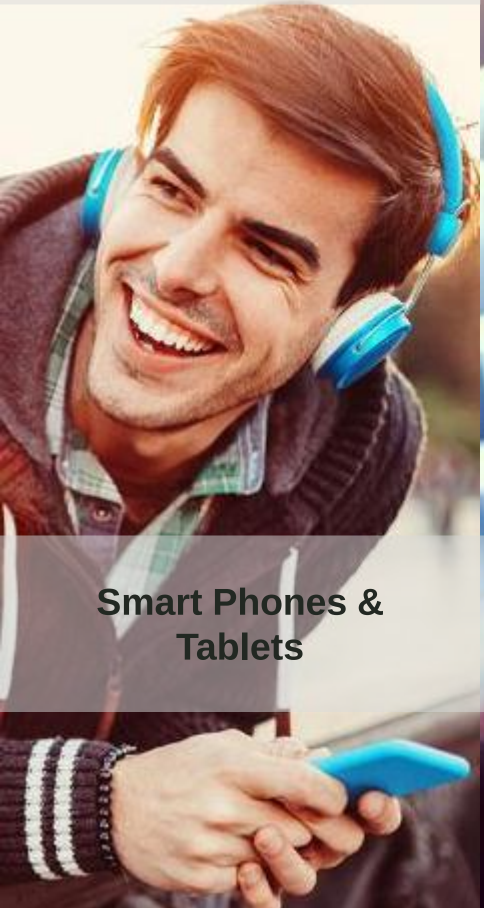
24.0 mm x 12.0 mm x 2.0 mm

FR01-S4-210

30.0 mm x 3.0 mm x 1.0 mm

MARKETS

FRACTUS ANTENNAS



Smart Phones & Tablets

IoT

Bluetooth/Wifi

ISM

Facing the Wireless Communication Era

- Smart meters
- IoT
- Parking Sensors
- Fleet Management
- Smart Home
- Smart City

Virtual Antenna™ Technology is a solution for connecting every single device through a miniature and off-the-shelf antenna component capable of being tuned at multiple frequency bands with a high level of performance

Facing the Wireless Communication Era

FRACTUS ANTENNAS

- Smart meters
- IoT
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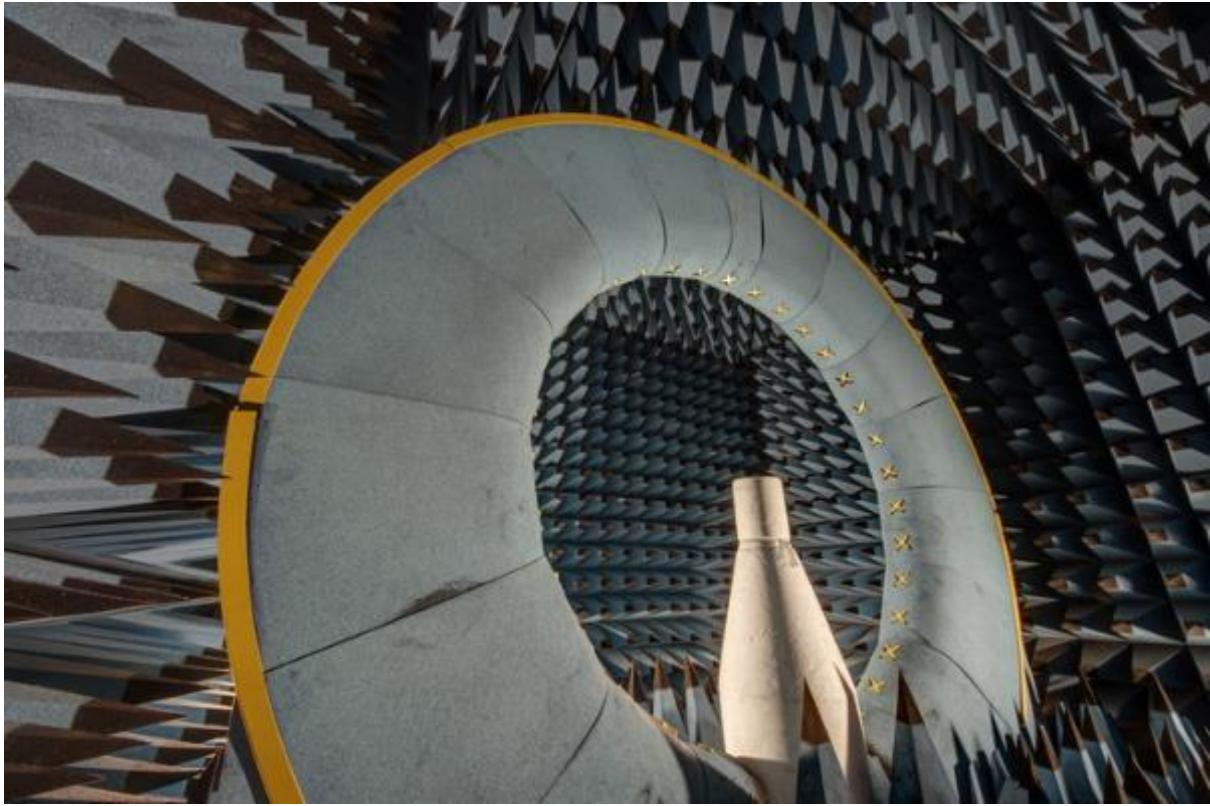
FACILITIES

- Two anechoic chambers including a SATIMO Stargate 32 and a chamber for active testing of smartphones.
- Full RF Lab including several vectorial network analyzers (VNAs)
- Bluetest Reverberation Chamber
- Antenna simulation tools: CST, IE3D, Microwave Office
- Gerber File Importation & Analysis
- Mechanical Prototyping Lab
- Chemical Prototyping Lab

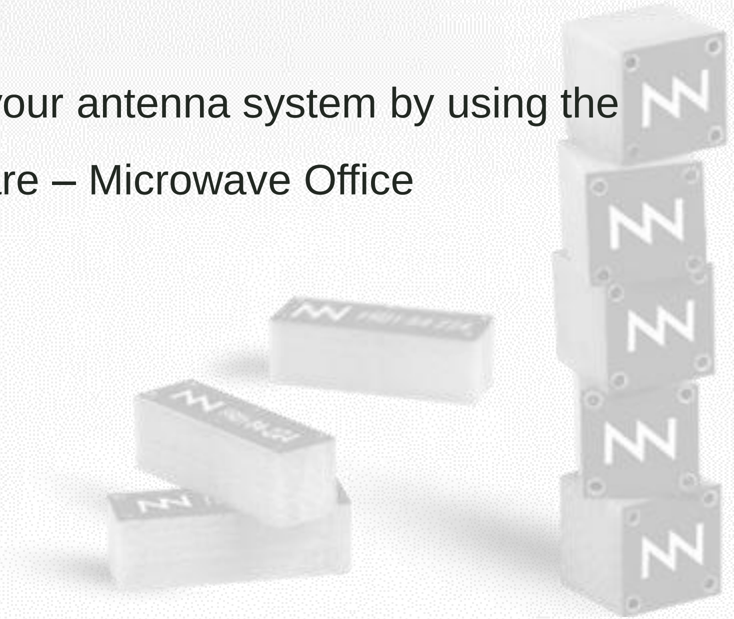


R&D SERVICES

1. NN-S-1.0 Wireless Fast Track Service
2. NN-S-2.0 Matching Network Optimization and Test
3. NN-S-3.0 Consultancy on Antenna Integration
4. NN-S-4.0 Consultancy on Wireless Device Certification

Agenda

- 9:00-9:30 Introduction
- 9:30-10:30 Part I: All About Virtual Antenna™ Technology
- 10:20-10:50 Coffee Break
- 10:50-12:30 Part II: Your turn: Design and check your antenna system by using the antenna boosters and the Electromagnetic Software – Microwave Office



NATIONAL INSTRUMENTS™

Virtual Antenna™ design for IoT Devices

Fractus Antenna

with NI AWR Design Environment

IoT Design Concerns

- Need for rapid development and integration of RF front-end modules in highly diverse IoT applications
- Address many flavors of IoT operating across multiple frequency bands and combinations of RF components: filters, antenna tuners, low-noise amplifiers, power amplifiers, etc.
- Address cost, range and power performance needs to utilize
  - Dedicated IoT networks like LoRa and SigFox
  - WiFi
  - 5G to enable long-distance versions such as NB-IoT and LTE-M.

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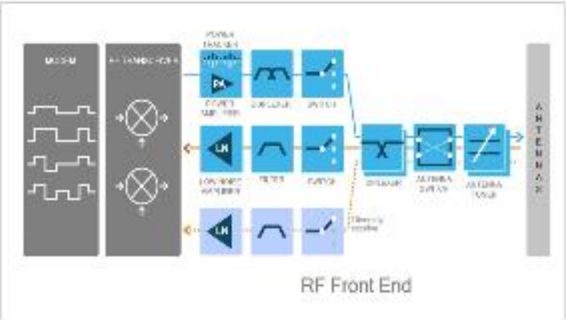


IoT RF module design including antenna integration

Many Implementations of IoT

Bluetooth – or Bluetooth Low Energy (BLE) or Bluetooth smart. Combined basic-data-rate and low-energy core configuration for a RF transceiver, baseband and protocol stack.
Freq: 2.4GHz (ISM), Range: 50-150m (Smart/BLE), Data Rates: 1Mbps (Smart/BLE)

Zigbee - Based on the IEEE802.15.4 protocol offers low power operation, high security, robustness and high scalability with high node counts .
Frequency: 2.4GHz, Range: 10-100mm, Data Rates: 250kbps

Z-wave - Designed for home automation networks.
Frequency: 900MHz (ISM), Range: 30m, Data Rates: 9.6/40/100kbit/s

6LowPAN - IPv6 Low-power wireless Personal Area Network, has the freedom of frequency band and physical layer and can also be used across multiple communications platforms, including Ethernet, Wi-Fi, 802.15.4 and sub-1GHz ISM.

LoRaWAN- Optimized for low-power consumption and supporting large networks with millions and millions of devices, Freq: various, Range: 2-5km (urban) and 15km (suburban) data rates range from 0.3 kbps to 50 kbps.

WiFi 802.11 b/g/n - - Frequencies: 2.4GHz and 5GHz bands, Range: Approximately 50m, Data Rates: 600 Mbps maximum, but 150-200Mbps is more typical, depending on channel frequency used and number of antennas

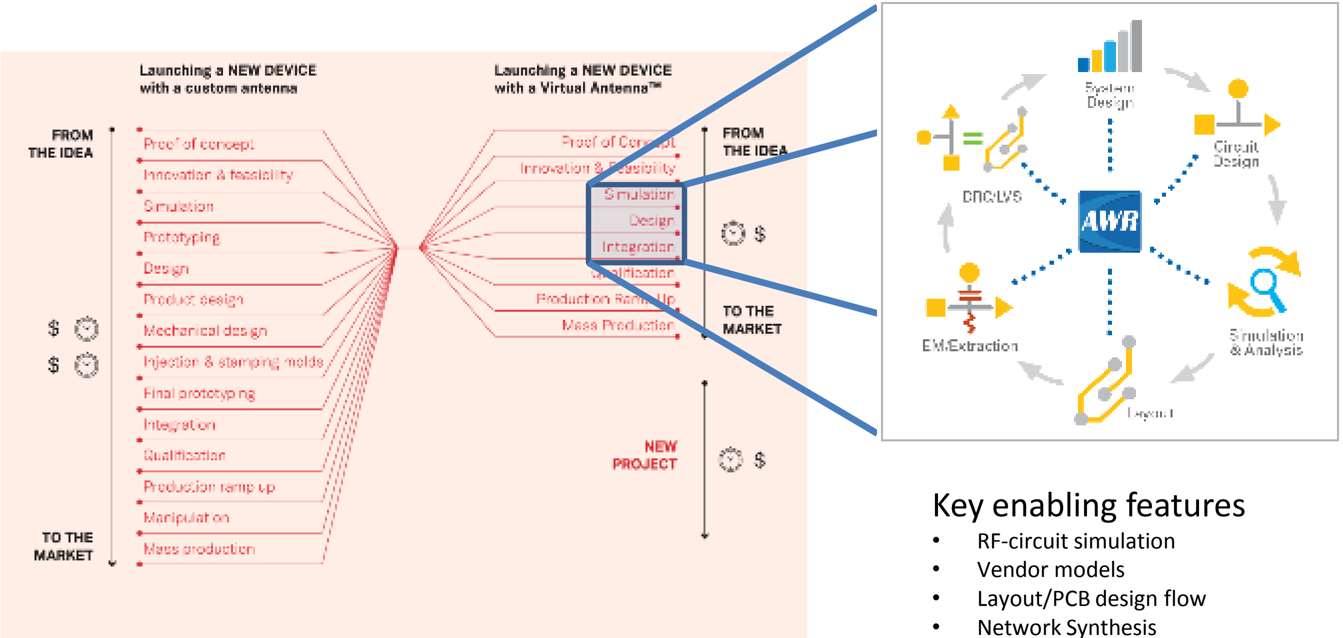
- **NFC** - Frequency: 13.56MHz (ISM)
- **Sigfox** - Frequency: 900MHz
- **Thread** - Frequency: 2.4GHz (ISM)
- **Neul** - Frequency: 900MHz (ISM), 458MHz (UK), 470-790MHz (White Space)

Cellular - Sensor-based low-bandwidth-data over longer distances can take advantage of GSM/3G/4G cellular communications. Frequencies: 900/1800/1900/2100MHz, Range: 35km max for GSM; 200km max for HSPA

A Collaboration to Address IoT Design

Goal: Reduce design complexity and engineering effort with a modular approach to IoT device development, design aids, models and simulation

Accelerating Concept to Product …

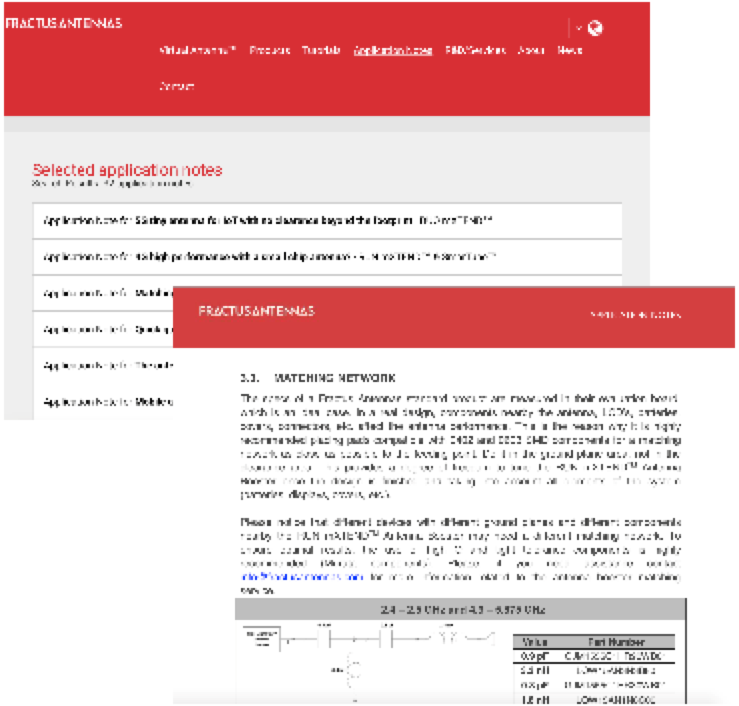


Virtual Antenna™ Benefits

Key enabling features

- RF-circuit simulation
- Vendor models
- Layout/PCB design flow
- Network Synthesis
- Tuning/optimization

Technical Collaboration



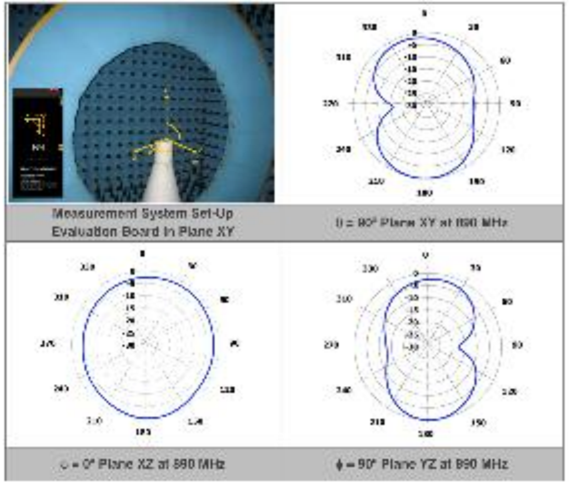
- Fractus Antenna Models are available in Microwave Office software for simulation
- Selection of application notes provides matching network details for implementation in Microwave Office software
- Surface-mount lumped element components also available in Microwave Office vendor libraries
- Use them to simulate, generate layout and integrate antenna into IoT front-ends

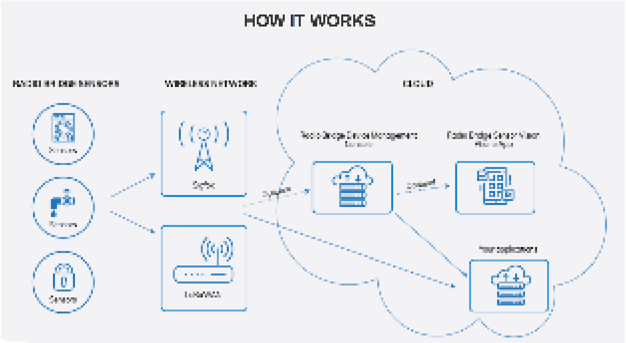
Device: RUN mXTEND™ (FR01-S4-224)

FRACTUS ANTENNAS APPLICATION NOTES

The antenna for IoT: NB-IoT, LoRa, Zigbee or Sigfox

- Product: RUN mXTEND™ FR01-S4-224
- Dimensions: 12.0 mm x 3.0 mm x 2.4 mm
- Frequency regions: 690-960 MHz, 1710-2690 MHz and 3400-3800 MHz





Gain	Peak Gain	1.6 dBi
	Average Gain across the band	1.0 dBi
	Gain Range across the band (min, max)	-0.3 <–> 1.6 dBi
Efficiency	Peak Efficiency	75.1 %
	Average Efficiency across the band	69.1 %
	Efficiency Range across the band (min, max)	54.1 – 75.1 %

Device: RUN mXTEND™ (FR01-S4-224)

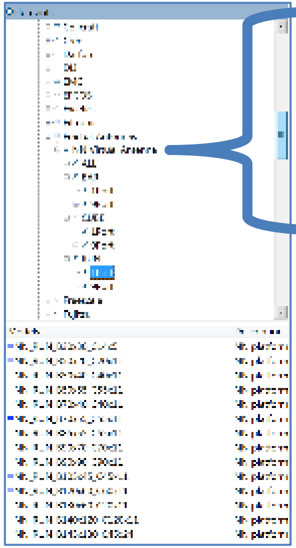
Material: The RUN mXTEND™ Antenna Booster is built on glass epoxy substrate.

APPLICATIONS

- Smart Metering
- Smart City & Smart Building
- Industrial IoT
- Remote monitoring and control
- Sensors
- Personal & Asset Tracking
- Fleet management
- RFID
- Retail
- Security Systems
- Smart Home
- Medical

BENEFITS

- High efficiency
- Small size
- Cost-effective
- Easy-to-use (pick and place)
- Multiband behaviour (worldwide standards)
- Off-the-Shelf Standard Product (no customization is required)



NI AWR Design Environment element browser: **Fractus Antenna** models in Vendor library

Application note:
https://www.fractusantennas.com/files/AN_FR01-S4-224_IoT-2.pdf

863 – 928 MHz

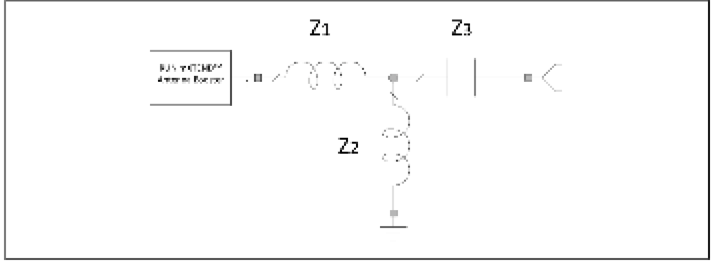
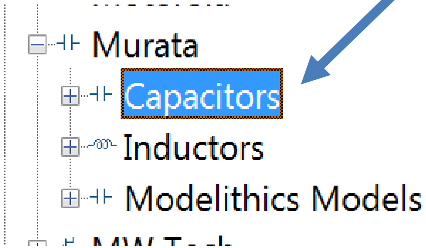


Figure 3 – Topology of matching network mounted for the different solutions.

Dimensions (B x C)	Z_1	Z_2	Z_3
75mm x 54mm	24nH	7.5nH	1.8pF
60mm x 54mm	25nH	6.8nH	[illegible]
40mm x 54mm	25nH	7.2nH	1.5pF
40mm x 40mm	27nH	7.2nH	2.1pF
40mm x 20mm	27nH	8.2nH	2.0pF

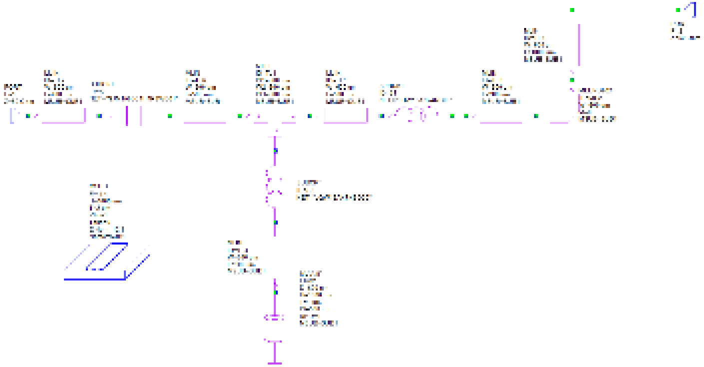
Value		Part Number
Z1	24nH	LQW18AN24NG00
	25 nH	LQW18AN25NG80
	27 nH	LQW18AN27NG80
Z2	7.5 nH	LQW18AN7N5C80
	6.8 nH	LQW18AN6N8C10
	7.2 nH	LQW18AN7N2C80
	8.2 nH	LQW18AN8N2C80
Z3	1.8 pF	GJM1555C1H1R8WB01
	1.5 pF	GJM1555C1H1R5WB01
	2.1 pF	GJM1555C1H2R1WB01
	2.0 pF	GJM1555C1H2R0WB0

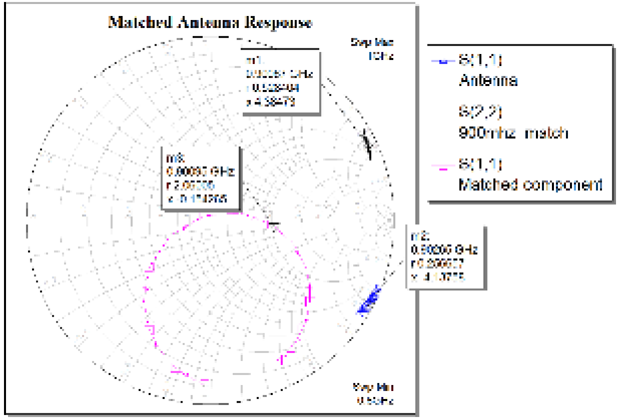
Suggested SMT components in matching circuit for
900 MHz operations
(Also in vendor library)

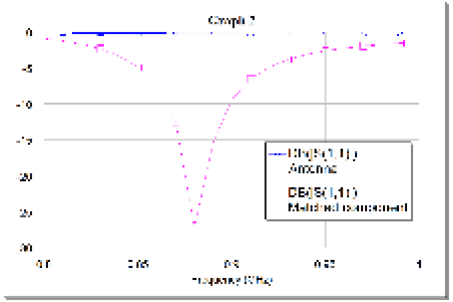


Matching Network (50 Ω)

Matching Network
Schematic: 900 MHz operations



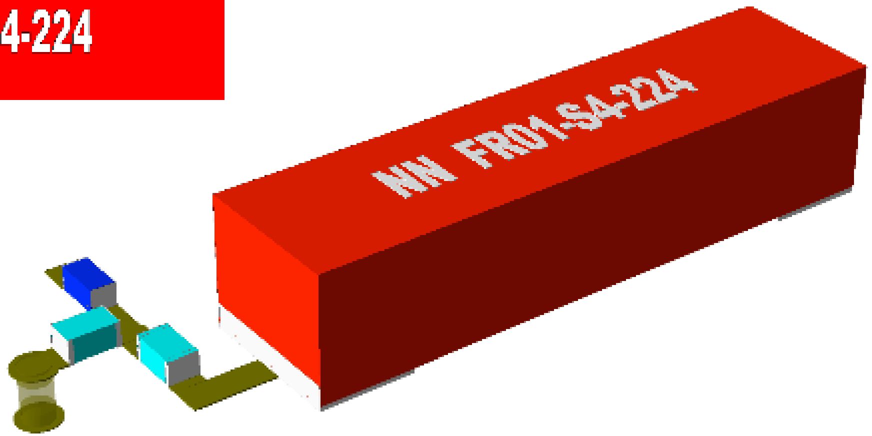




Matching Network (Layout)

2D view

3D view

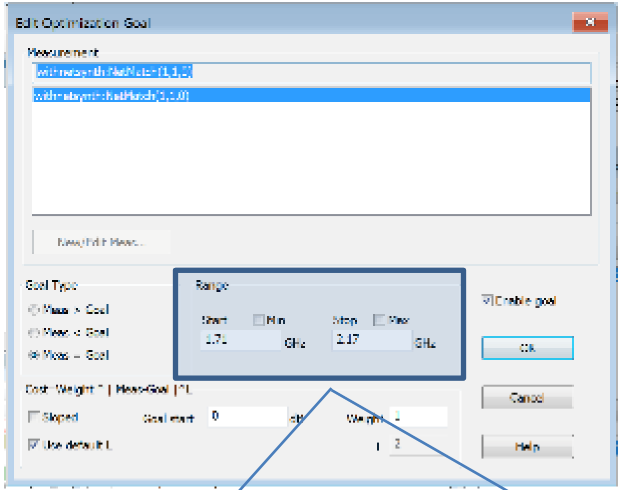


Matching Circuit Design Support with Network Synthesis

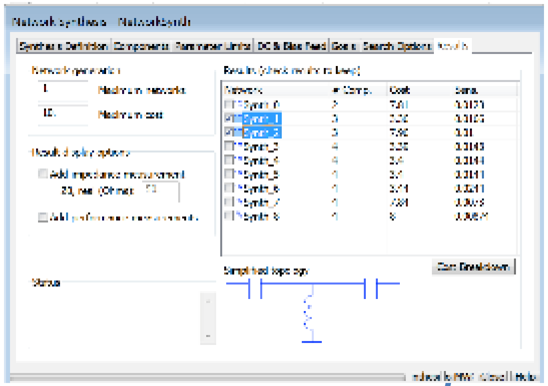
EDI CON 2019
Electronic Design Innovation Conference
电子设计创新大会
April 1-3, 2019
China National Convention Center
Beijing, China

Design Support: Network Synthesis

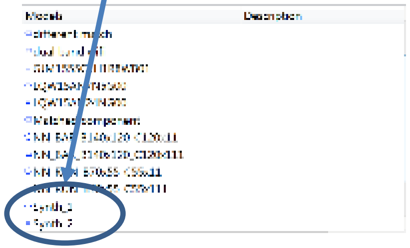
Define matching goals

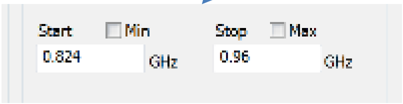


Multiple synthesized solutions



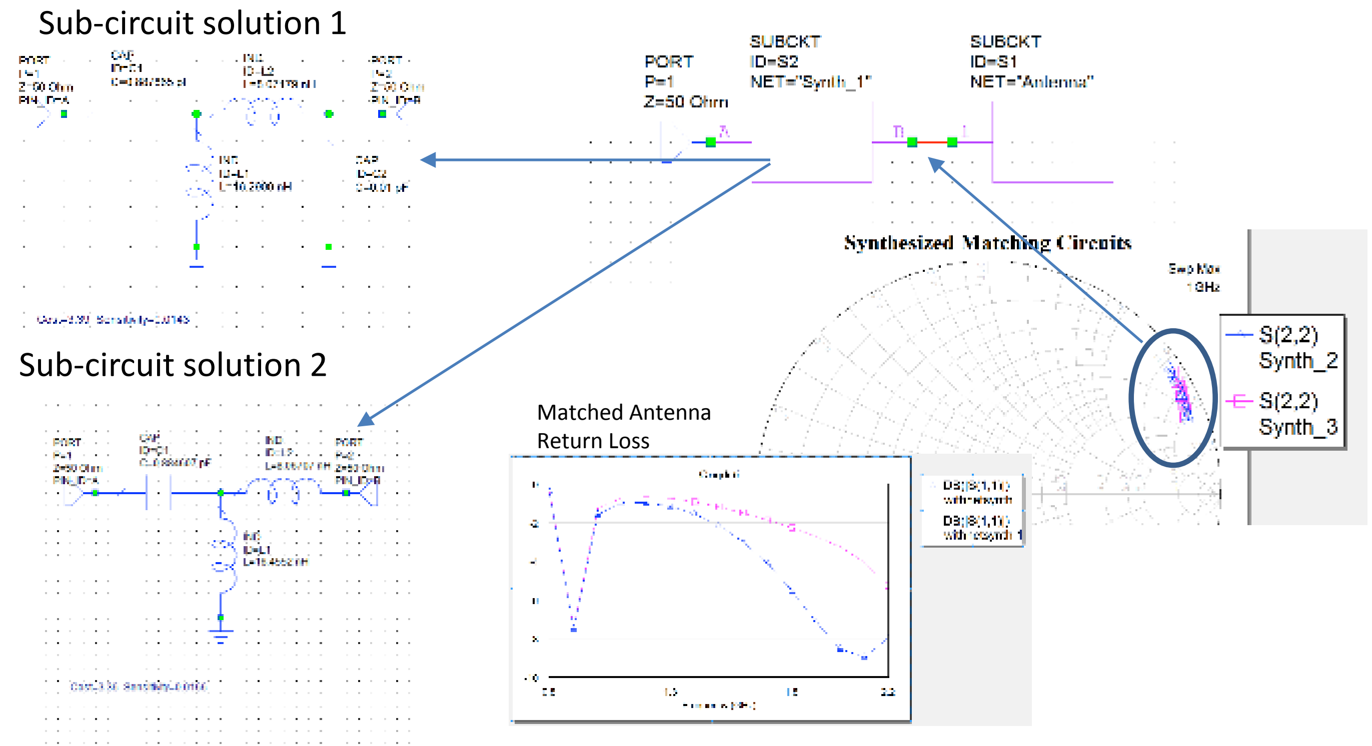
Export to
MWO project





Multiple goals (i.e. frequency bands) can be defined

Design Support: Network Synthesis



Alternative matching example

(Non-50 Ω case)

Hervé Callewaert

RFO output inpedance for SX1272 / SX1276 and SX1261 chip

Hello,

I use those chip in miniaturized module, and I had some trouble on performance of TX matching network, and it occur a reduction of TX output power compared to Dev kit performance. I need to adjust the values of my BoM

I want to know the output Z of the RFO path when the transceiver work at +13/14 dBm

Thansk for your feed back.

Regards

Herve Callewaert

Hi Hervé,

At 14 dBm, the required load impedance seen by the RFO pin of SX1272 or SX1276 at 868 MHz is 14 + j 4 Ohms.

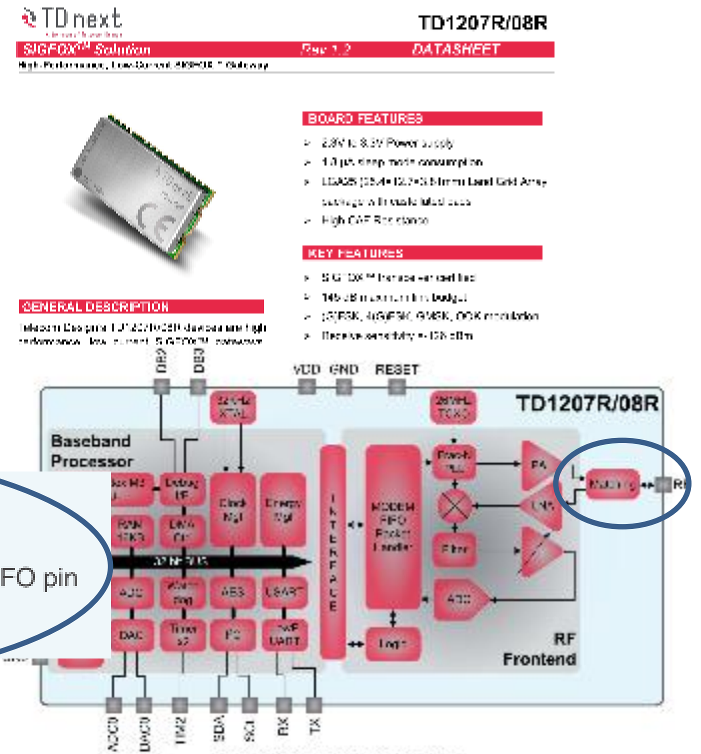
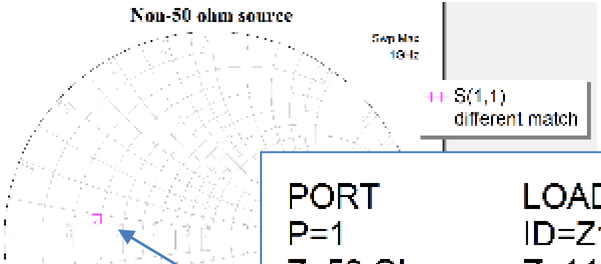
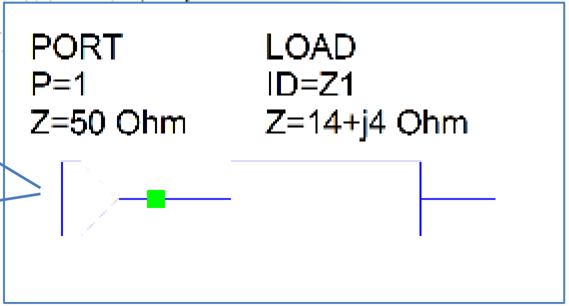


Figure 1. TD1207R/08R block diagram

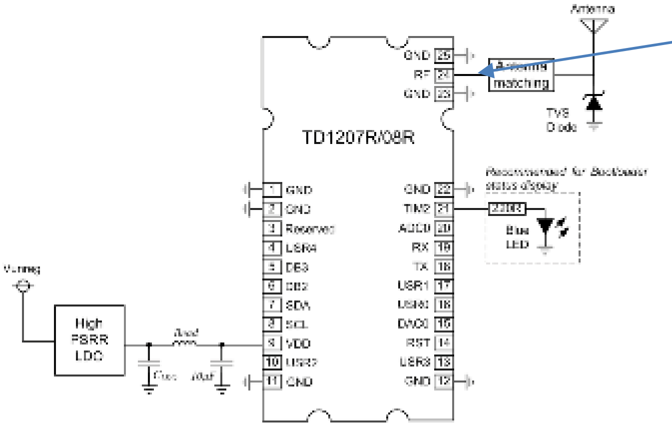
Alternative matching requirements

(non-50 Ω)



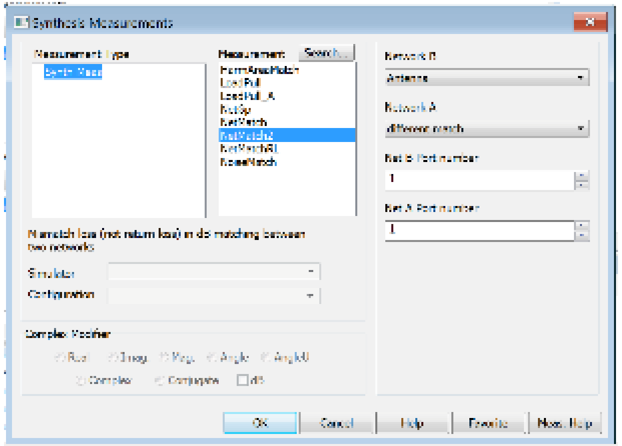


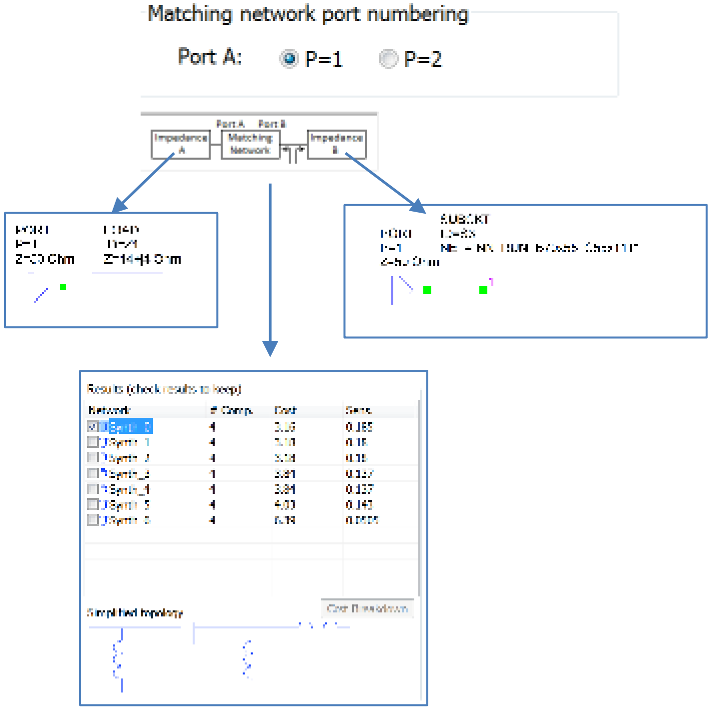
Simple source impedance model



Alternative matching requirements

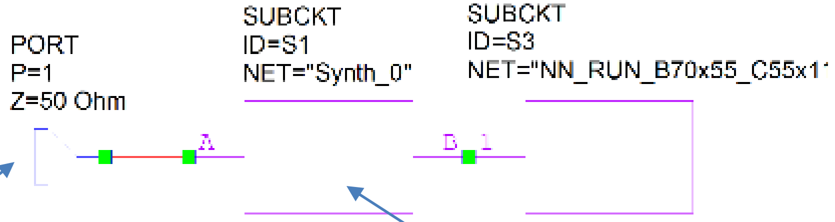
(non-50 Ω)



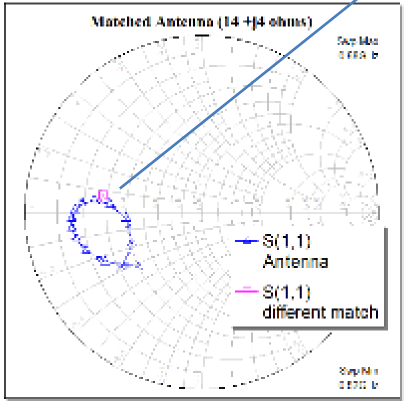


Alternative matching requirements

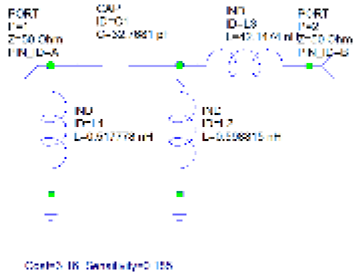
(non-50 Ω)



Antenna matched to required module load impedance of **14+j4 ohm** (mid-band)



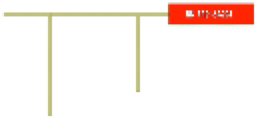
Synthesized matching network Inserted in front of antenna

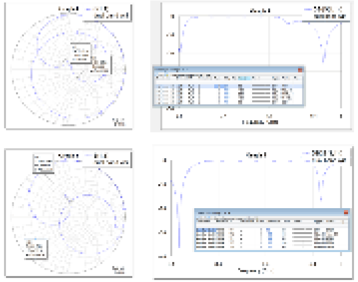


Additional Useful Design Support Features

Interactive Real-time Tuning

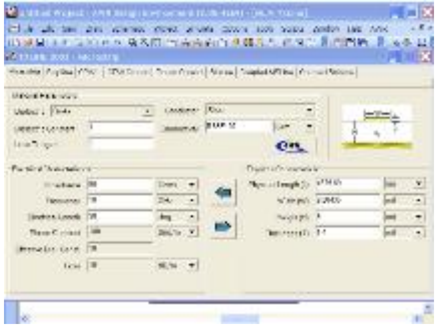
Example: Dual band WiFi distributed transmission line matching – optimizing return loss while addressing size and manufacturing considerations



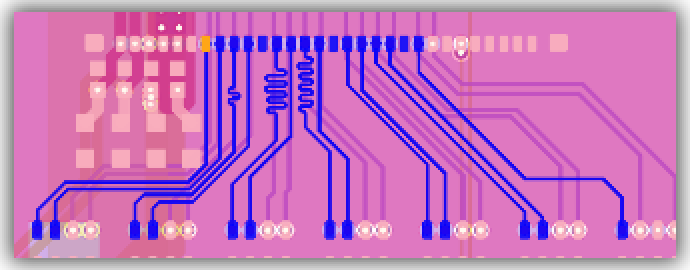


Distributed matching circuits

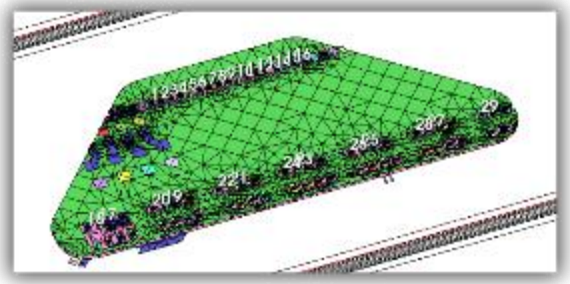
Transmission Line Calculator



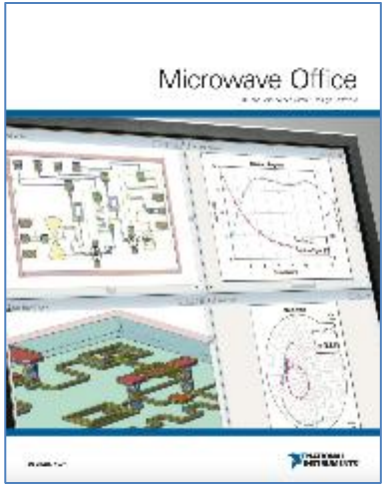
PCB Import



EM Analysis



NI AWR Design Solutions for IoT

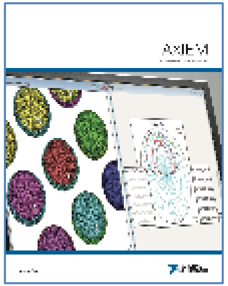


Microwave Office
Features at a Glance

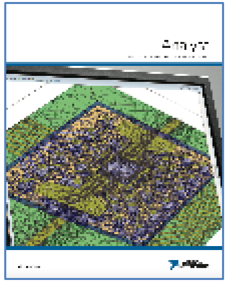
- Schematic/Layout – Design entry with industry-leading tuning
- APLAC – Linear and nonlinear circuit simulation
- EM Analysis – Fully integrated circuit/EM co-simulation
- Load-Pull – State-of-the-art load-pull analysis
- DRC/LVS – Design rule checking/layout vs. schematic
- Synthesis - Network matching and filter synthesis wizards

(Options)

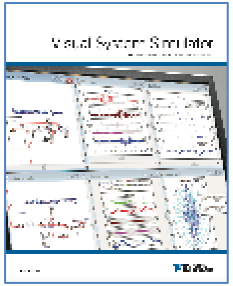
AXIEM
Planar EM



Analyst
3D EM



VSS
System Simulation

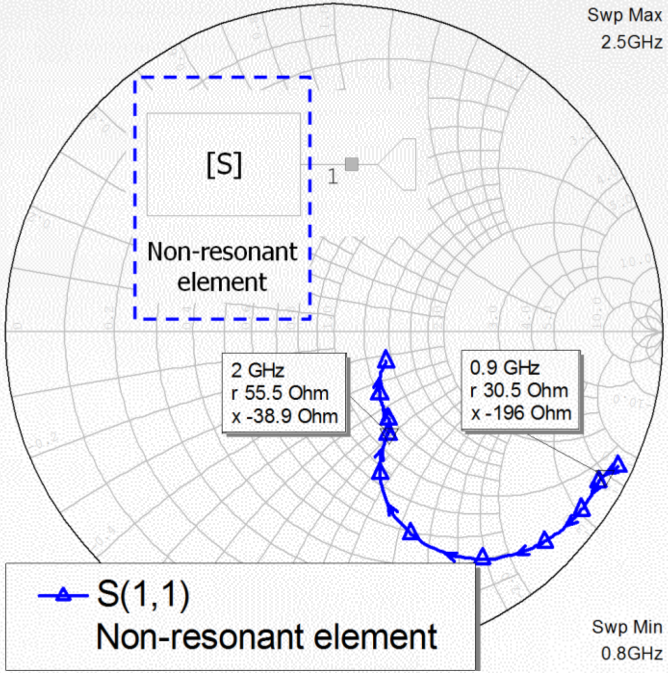


Learn more
ni.com/awr
awr.tv

About Virtual Antenna™ Technology

- Introduction
- Basic Antenna Parameters
- About Inductors and Capacitors
- Video Tutorials
- Some Practical Examples

Introduction: Matching Network Design

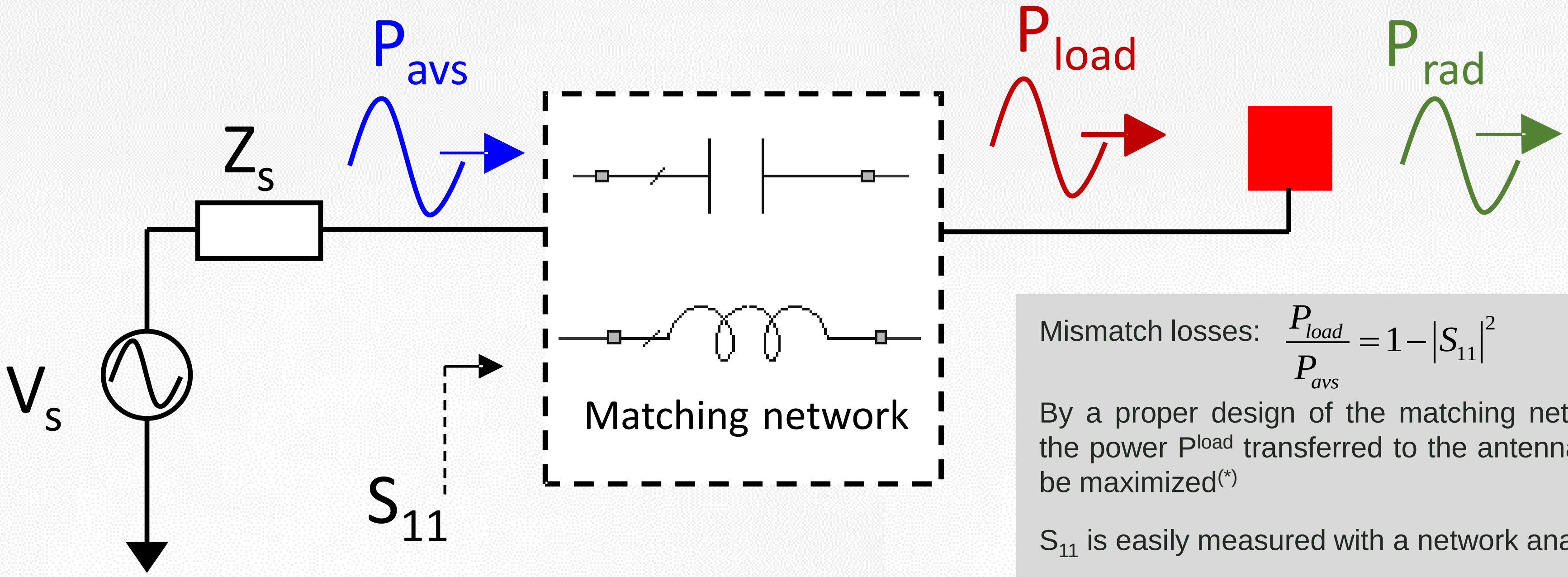


note: this simulated impedance correspond to the RUN mXTEND™ antenna booster on a 120 mm x 60 mm ground plane without a matching network

- **How can the reactive impedance be matched at two different frequency regions?**
- **Can we match at 824-960MHz and 1710-2690MHz?**
- **Can we match at 698-960MHz and 1710-2200MHz?**

Matching Network Design: S_{11}, SWR, Efficiency

- S_{11}/SWR takes into account how much power from the generator (P_{avs}) is delivered to the antenna P_{load} (not to space)



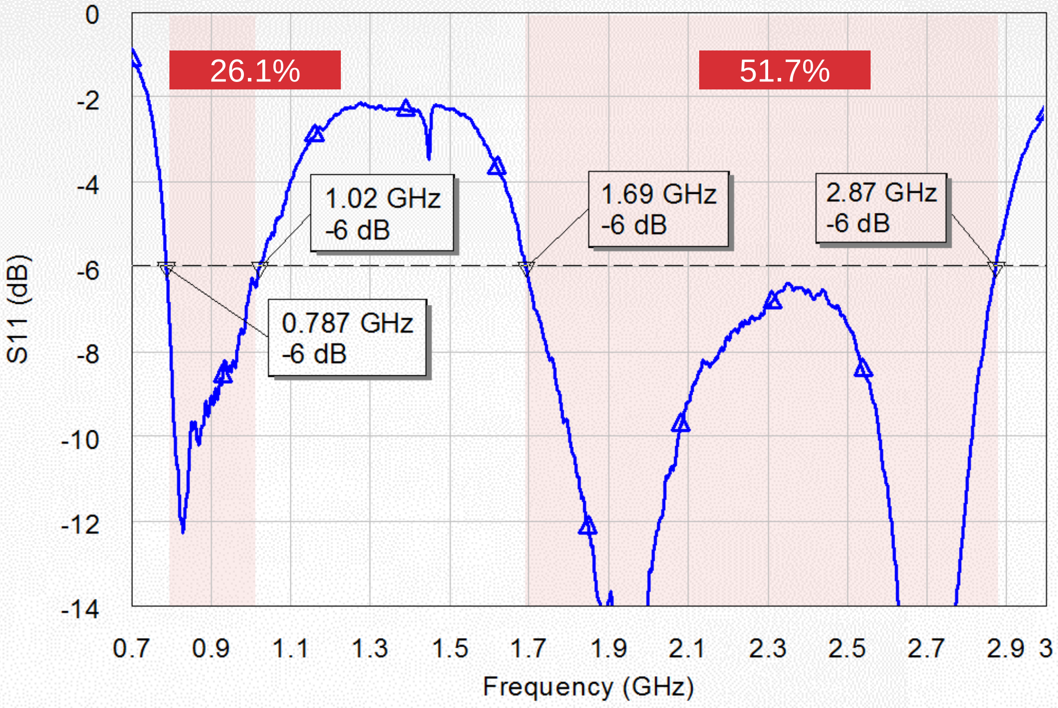
Mismatch losses: $\frac{P_{load}}{P_{avs}} = 1 - |S_{11}|^2$

By a proper design of the matching network, the power P^{load} transferred to the antenna can be maximized(*)

S_{11} is easily measured with a network analyzer

(*) Equation holds for a lossless matching network

Basic Antena Parameters: S_{11} and Bandwidth



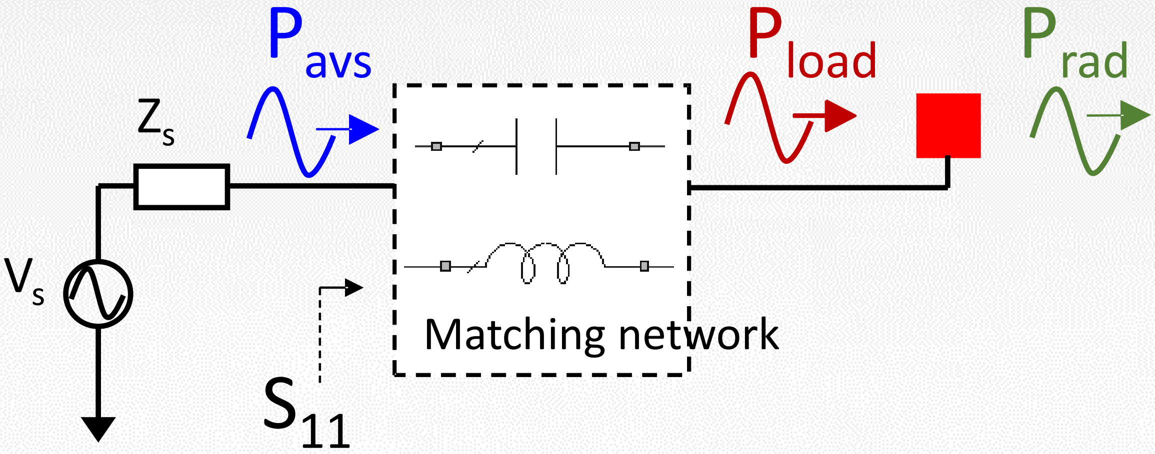
$$BW(\%, SWR \leq 3) = \frac{f_2 - f_1}{\frac{f_2 + f_1}{2}} \times 100$$

	824-960MHz	1710-2690MHz
BW (%)	15.2	44.5

R&S®ZNLE Vector Network Analyzer

Basic Antena Parameters: Efficiency

- Efficiency takes into account the power radiated to space (P_{rad})



Radiation Efficiency: $\frac{P_{rad}}{P_{load}} = \eta_r$

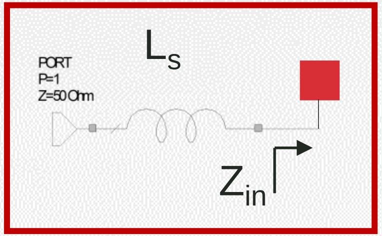
Total efficiency: $\frac{P_{rad}}{P_{avs}} = \eta_t = \eta_r \left(1 - |S_{11}|^2\right)$

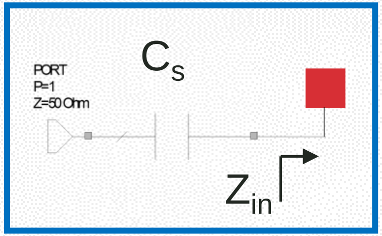
SWR	S_{11} (dB)	1-S_{11} (%)	1-S_{11} (dB)
6	-2.9	49.0	-3.1
3	-6.0	75.0	-1.2
2	-9.5	88.9	-0.5
1.5	-14.0	96.0	-0.2

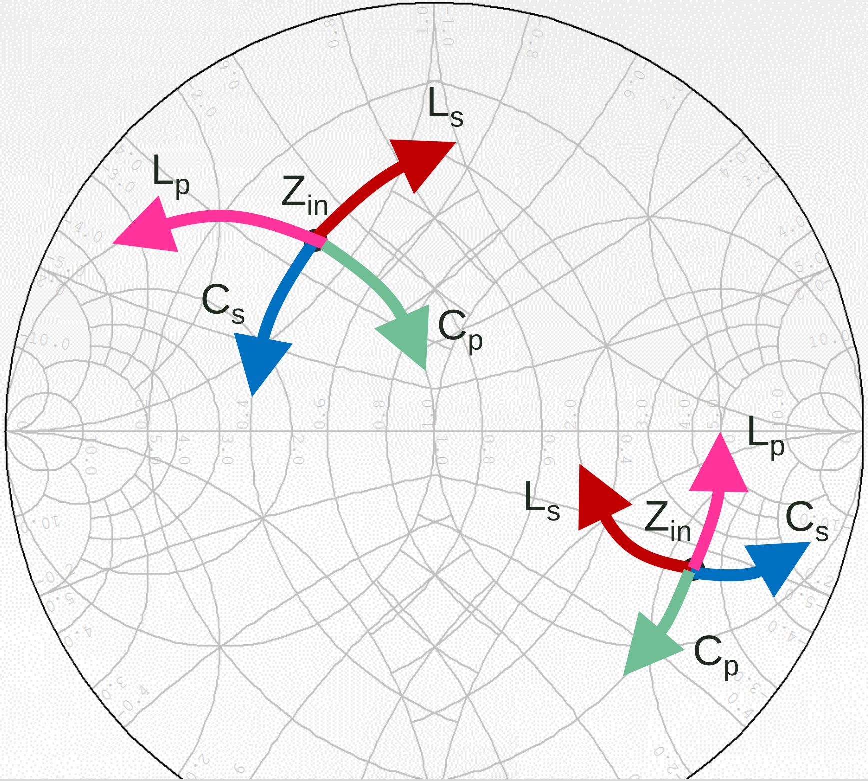
Basic Antena Parameters: Efficiency

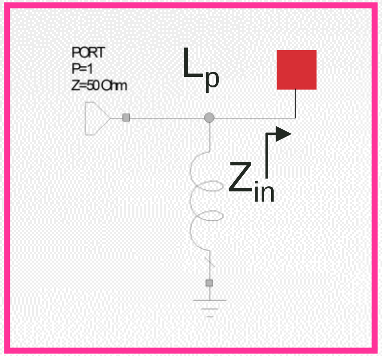
FRACTUS ANTENNAS

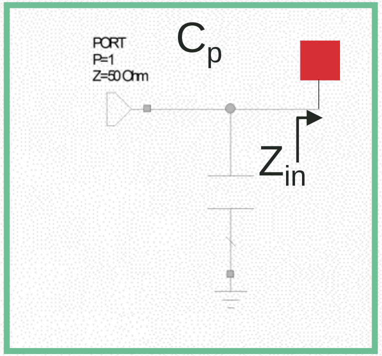
The Smith Chart: Basic Matching Network Movements





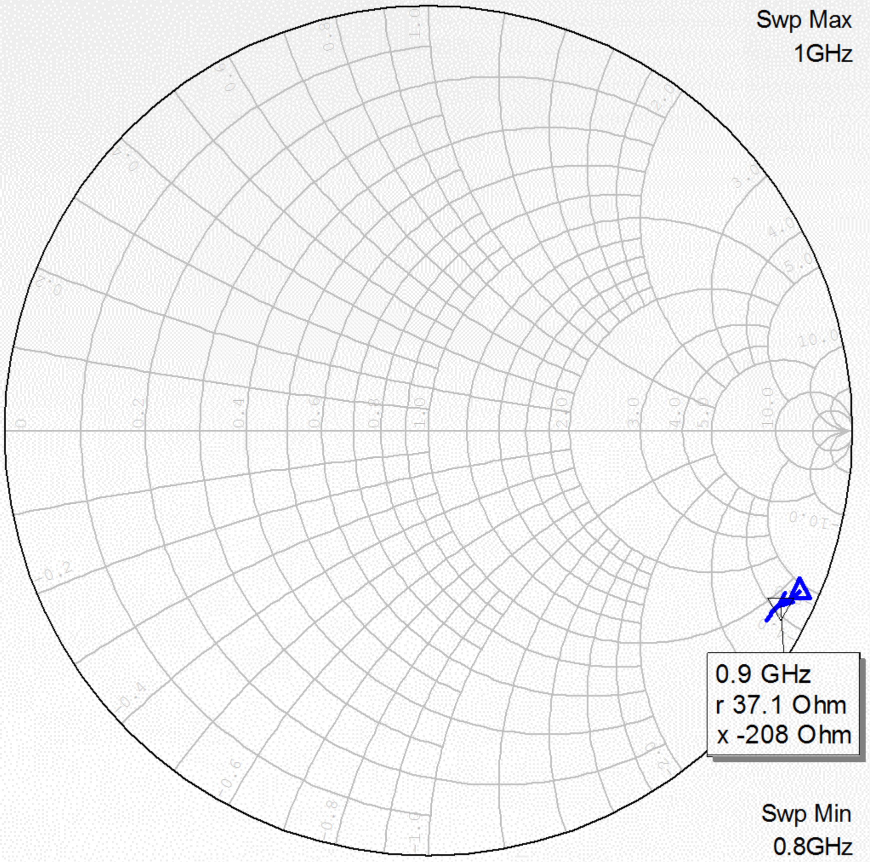


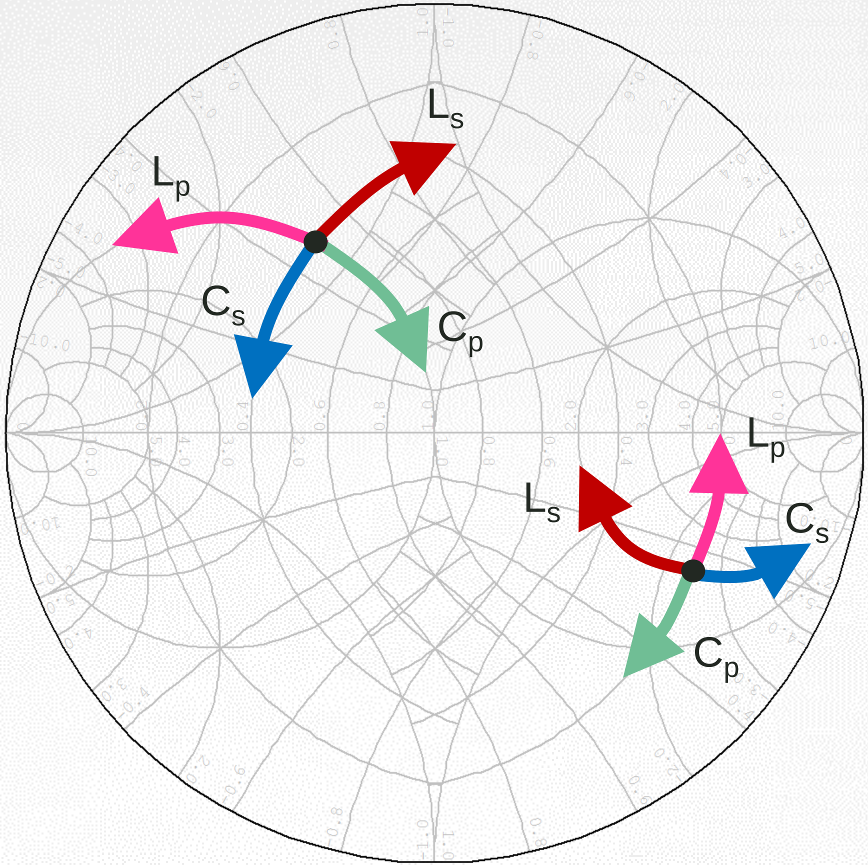




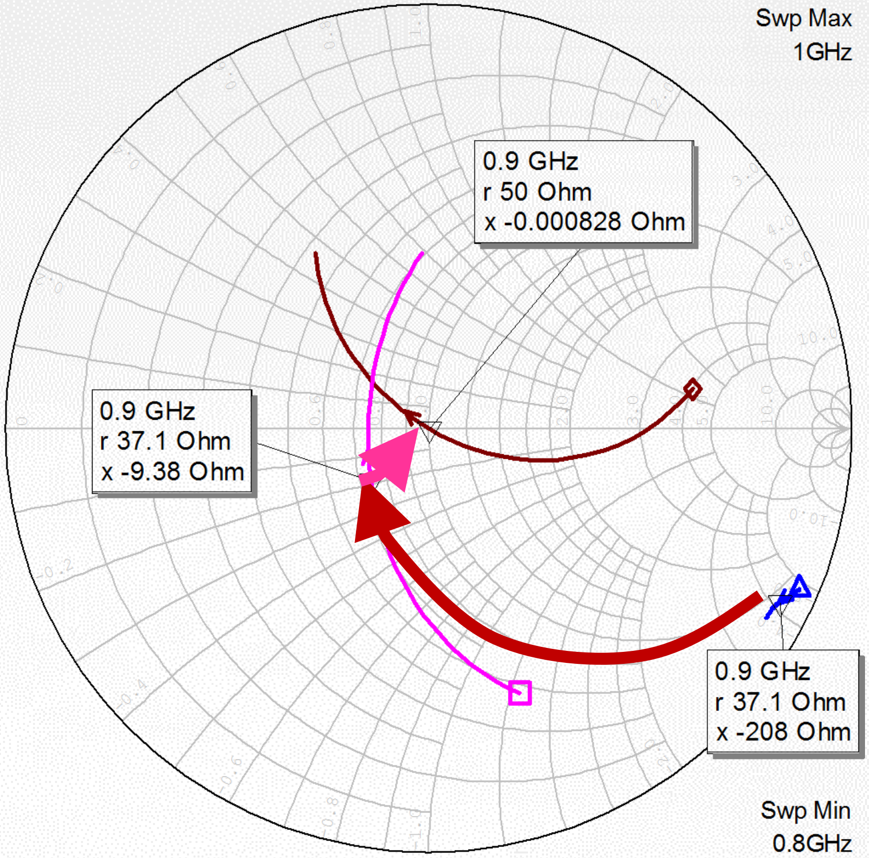
Inductors increase reactance
Capacitors decrease reactance

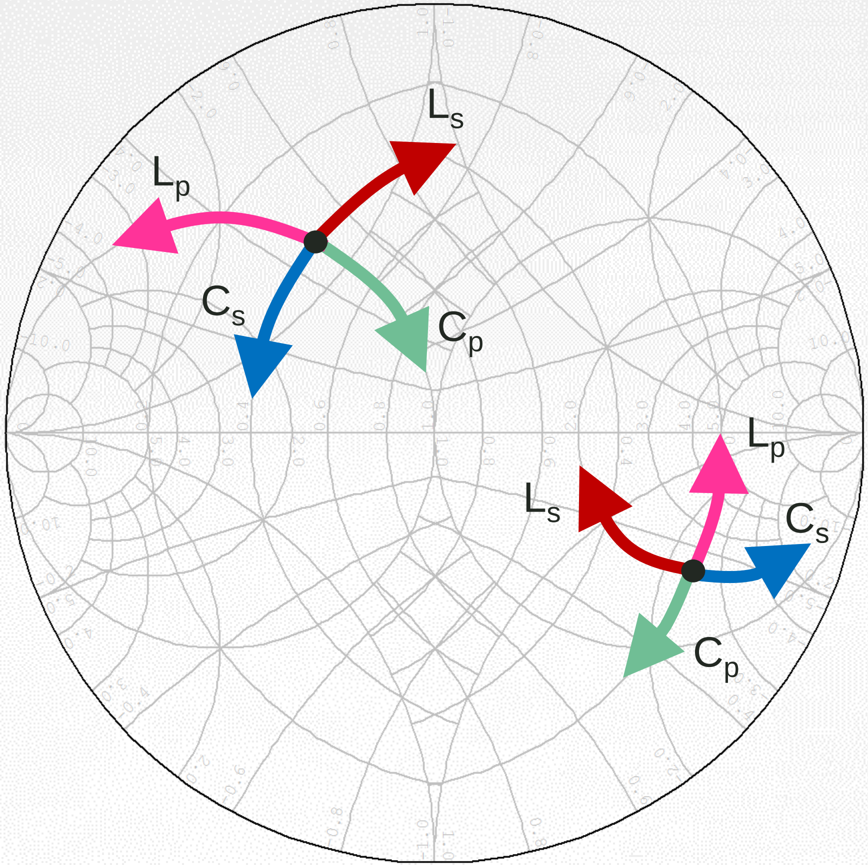
An example (I): Can you Propose a Matching Network?



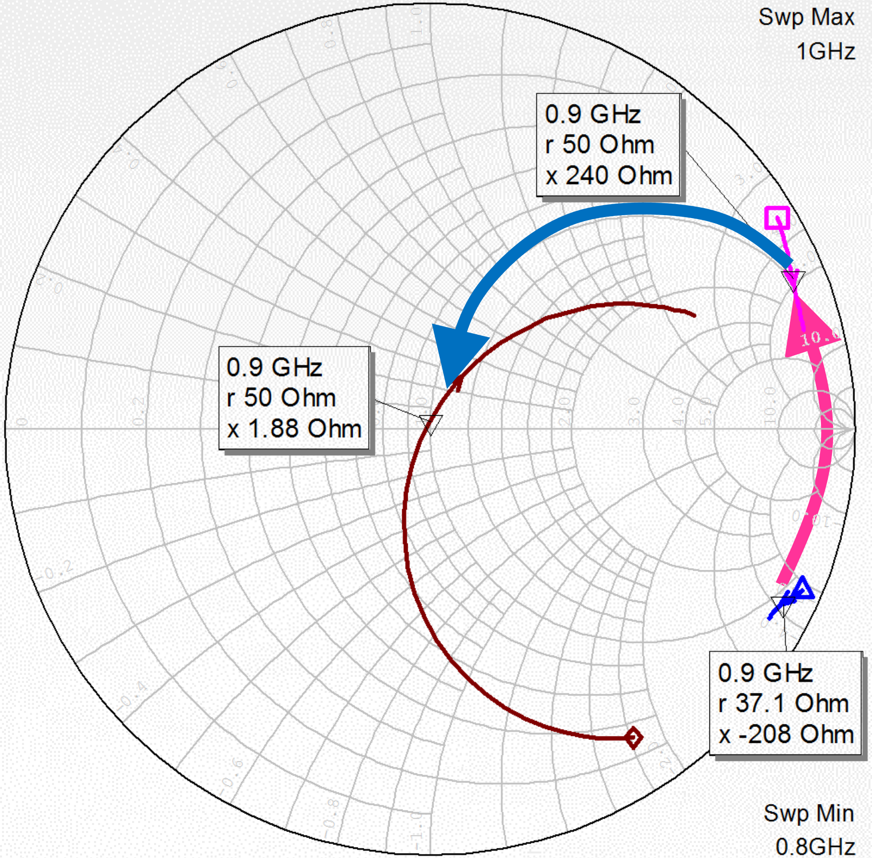


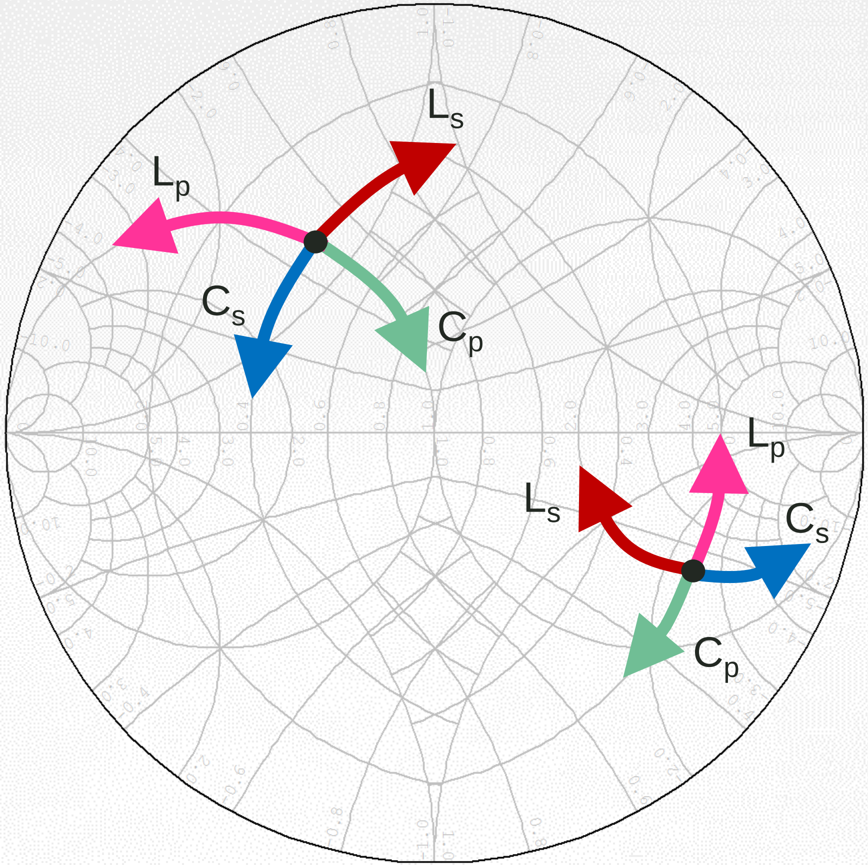
An example (II): Ls + Lp





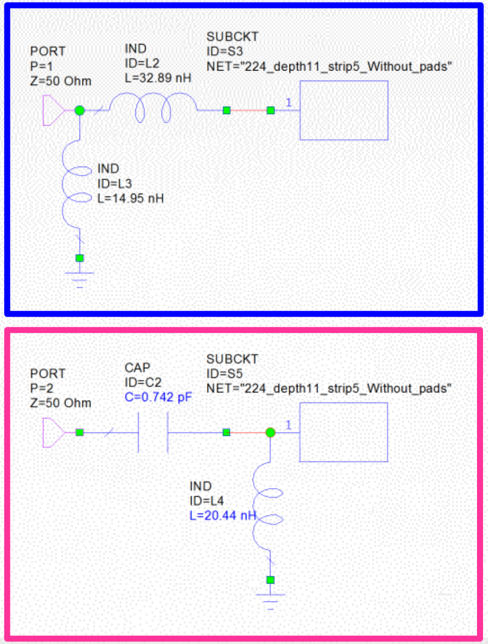
An example (III): Lp + Cs

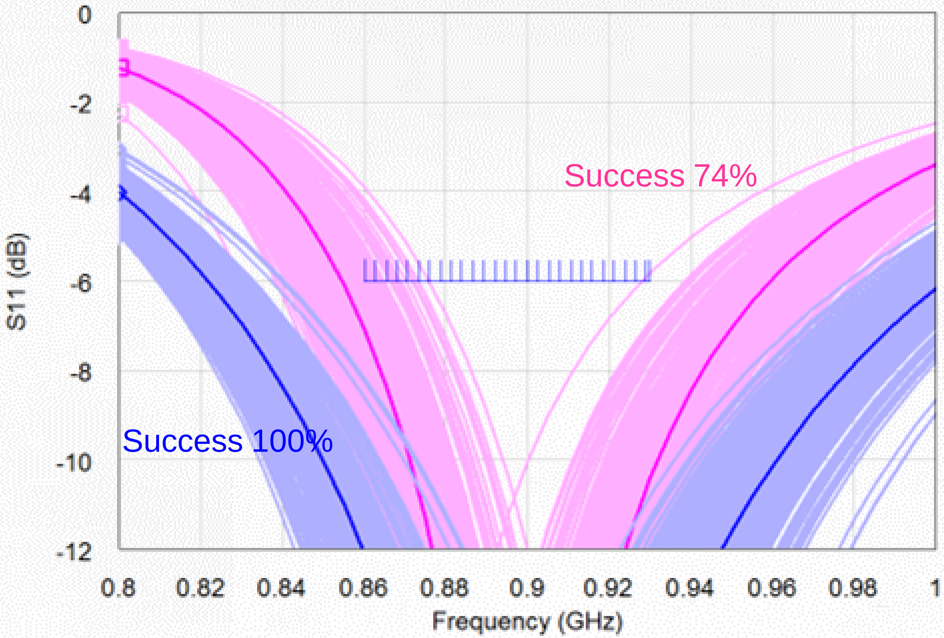




Several solutions…then, which one is the best?

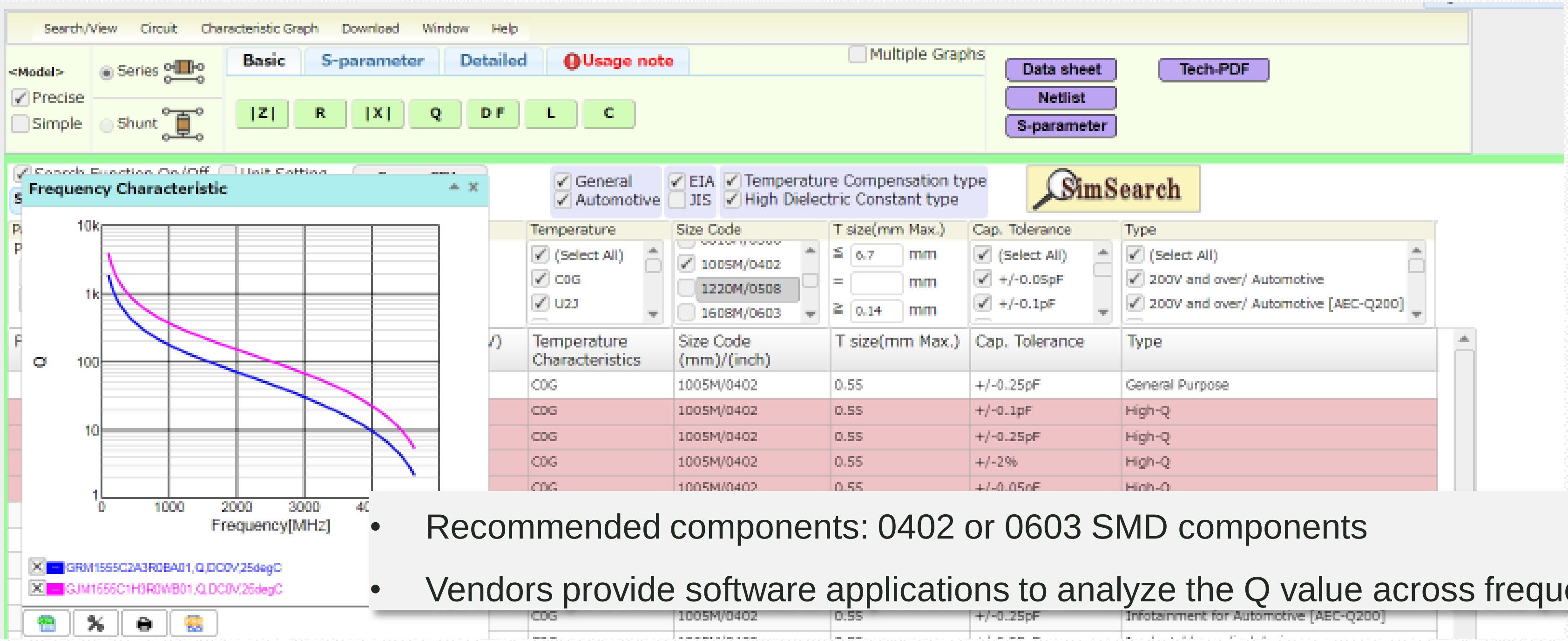
- The one that has enough bandwidth for your application and…
- … has less number of components
- … robust to tolerance analysis
- … low losses





About Inductors and Capacitors

- Do I need to know somethings else besides an L or C value? Yes, Q matters!!
  - **The largest the Q, the better**



- Recommended components: 0402 or 0603 SMD components
- Vendors provide software applications to analyze the Q value across frequency

http://ds.murata.co.jp/software/simsurfing/en-us/index.html

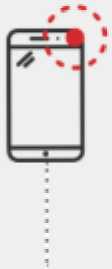
Video Tutorials

Easy. In only 3 simple steps you can obtain high antenna performance in the smallest space ever.

https://www.fractusantennas.com/tutorials/

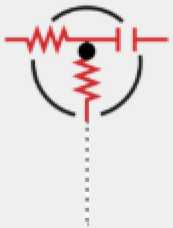
STEP 1

Place the antenna component



STEP 2

Design your matching network

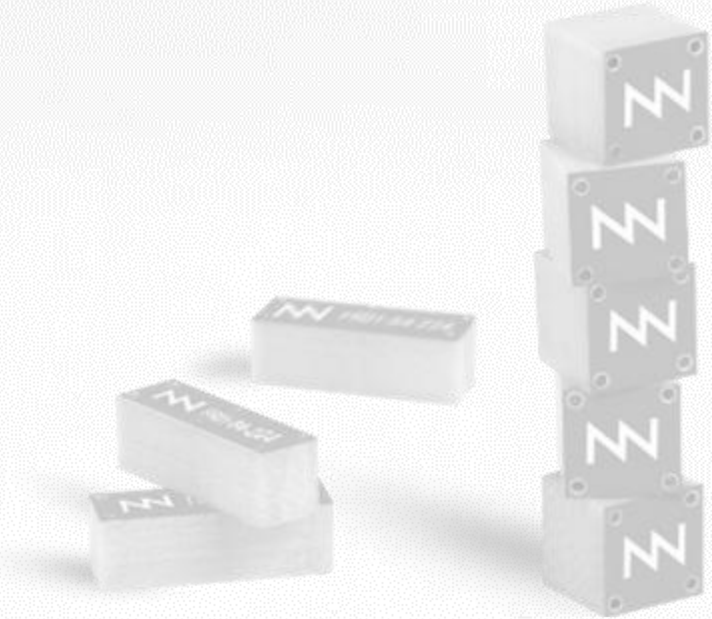


STEP 3

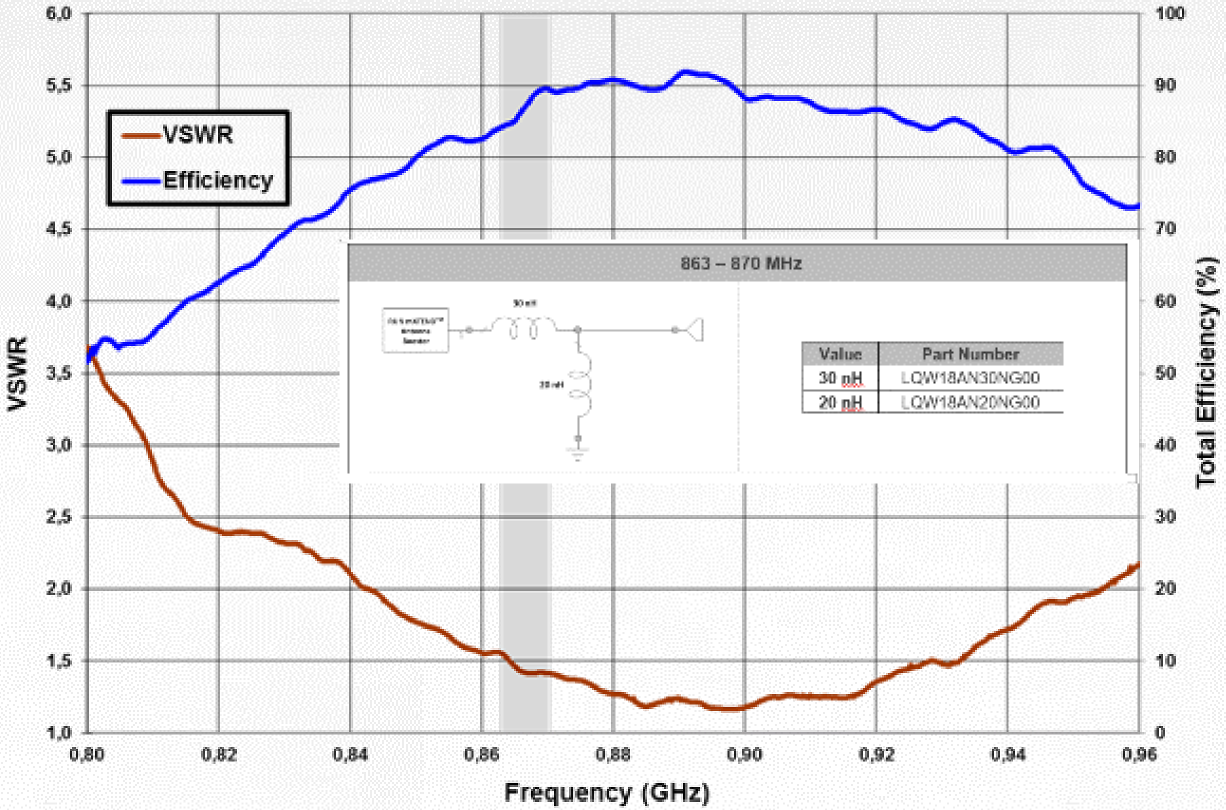
Test your device

Some Practical Examples

1. ISM Design
2. 2G, 3G Design
3. 2G, 3G, 4G Design
4. 2G, 3G Design in Smart-Meters

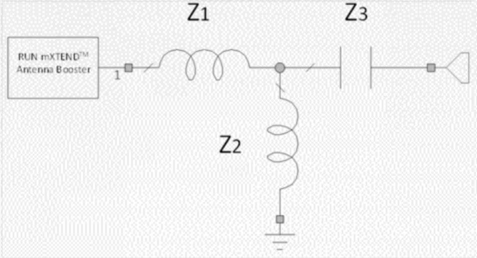


ISM Design (1/2)

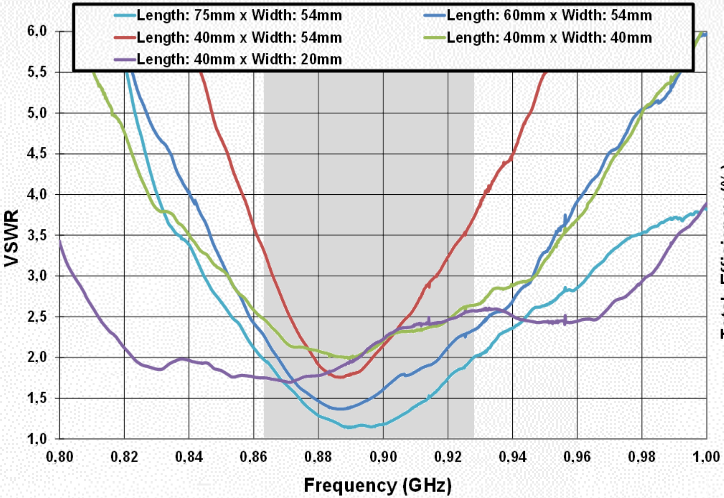


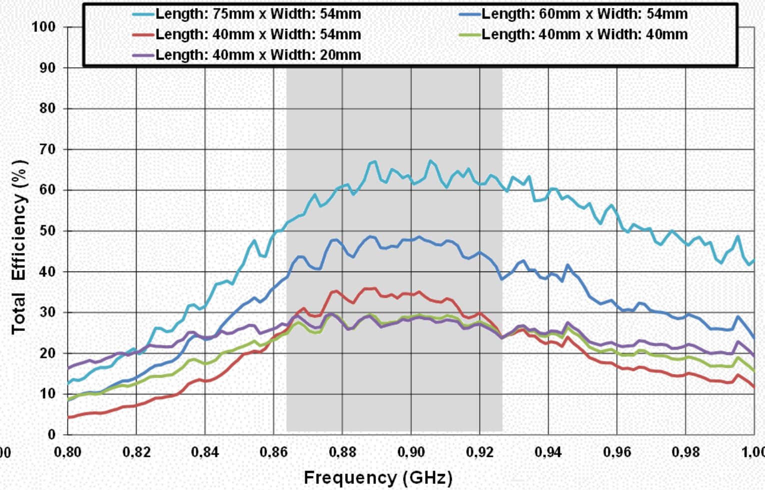
ISM Design (2/2)

Measure	mm
A	86 - 51
B	75 - 40
C	54 - 20
D	8
E	5

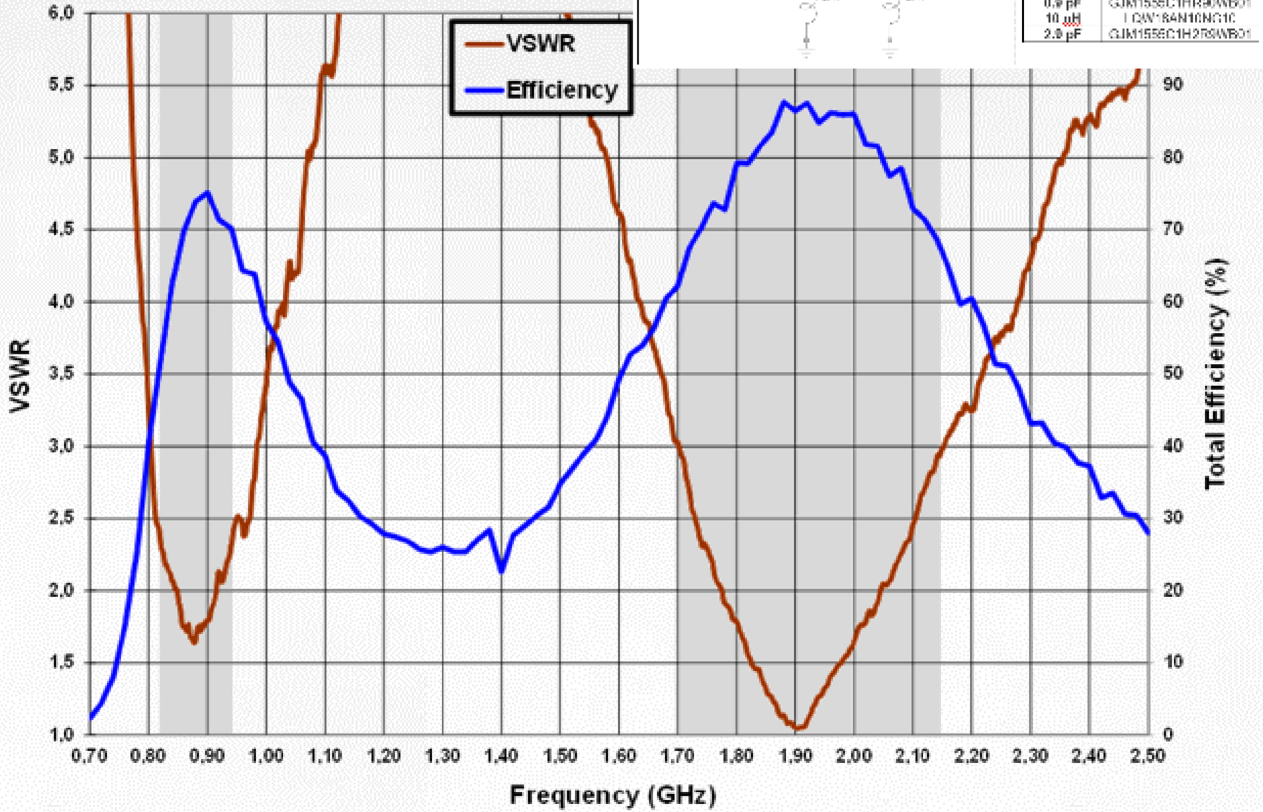


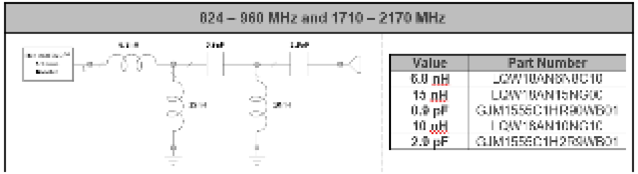
Dimensions (B x C)	Z_1	Z_2	Z_3
75mm x 54mm	24nH	7.5nH	1.8pF
60mm x 54mm	25nH	6.8nH	1.8pF
40mm x 54mm	25nH	7.2nH	1.5pF
40mm x 40mm	27nH	7.2nH	2.1pF
40mm x 20mm	27nH	8.2nH	2.0pF





2G, 3G Design

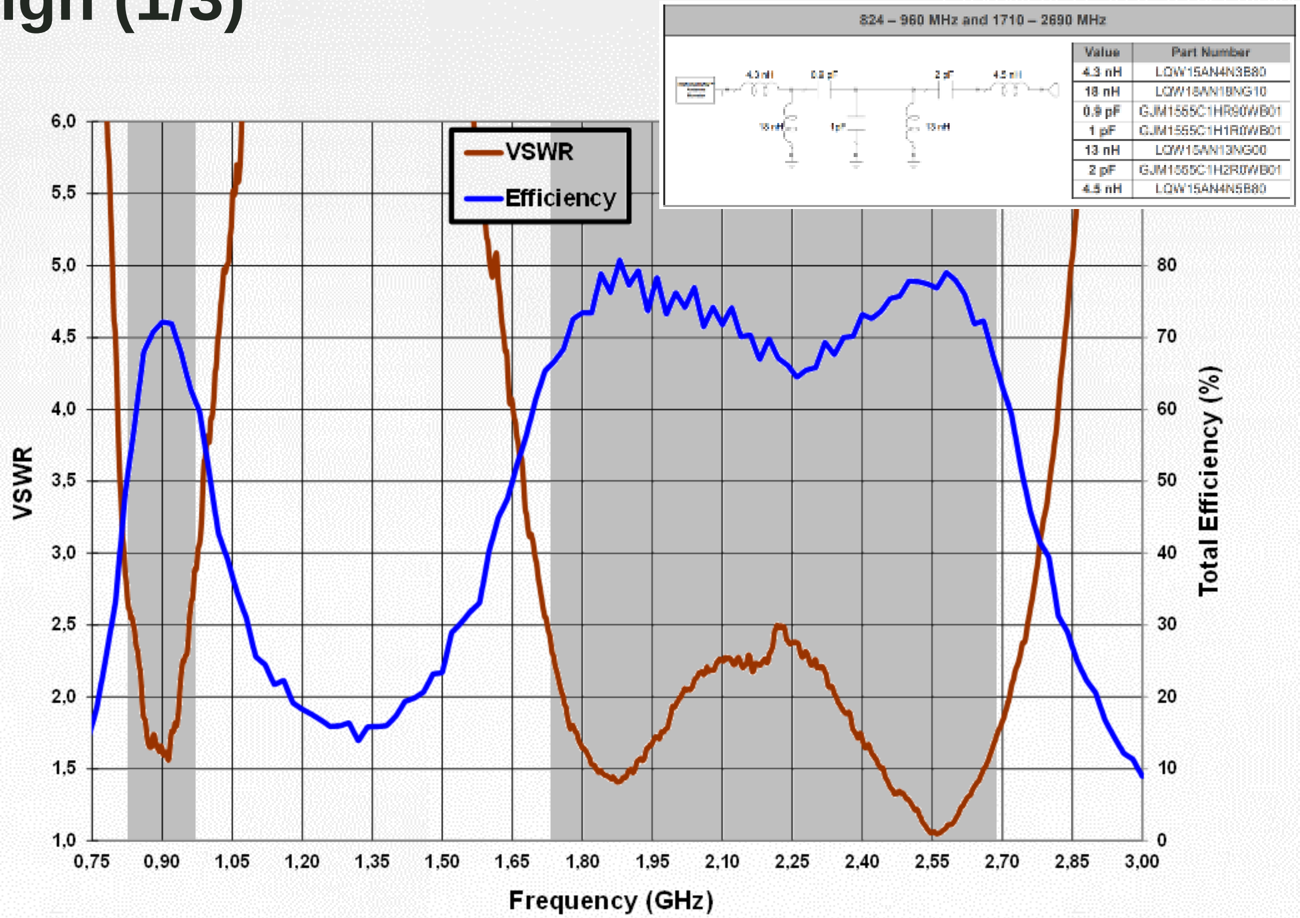




824 – 960 MHz and 1710 – 2170 MHz

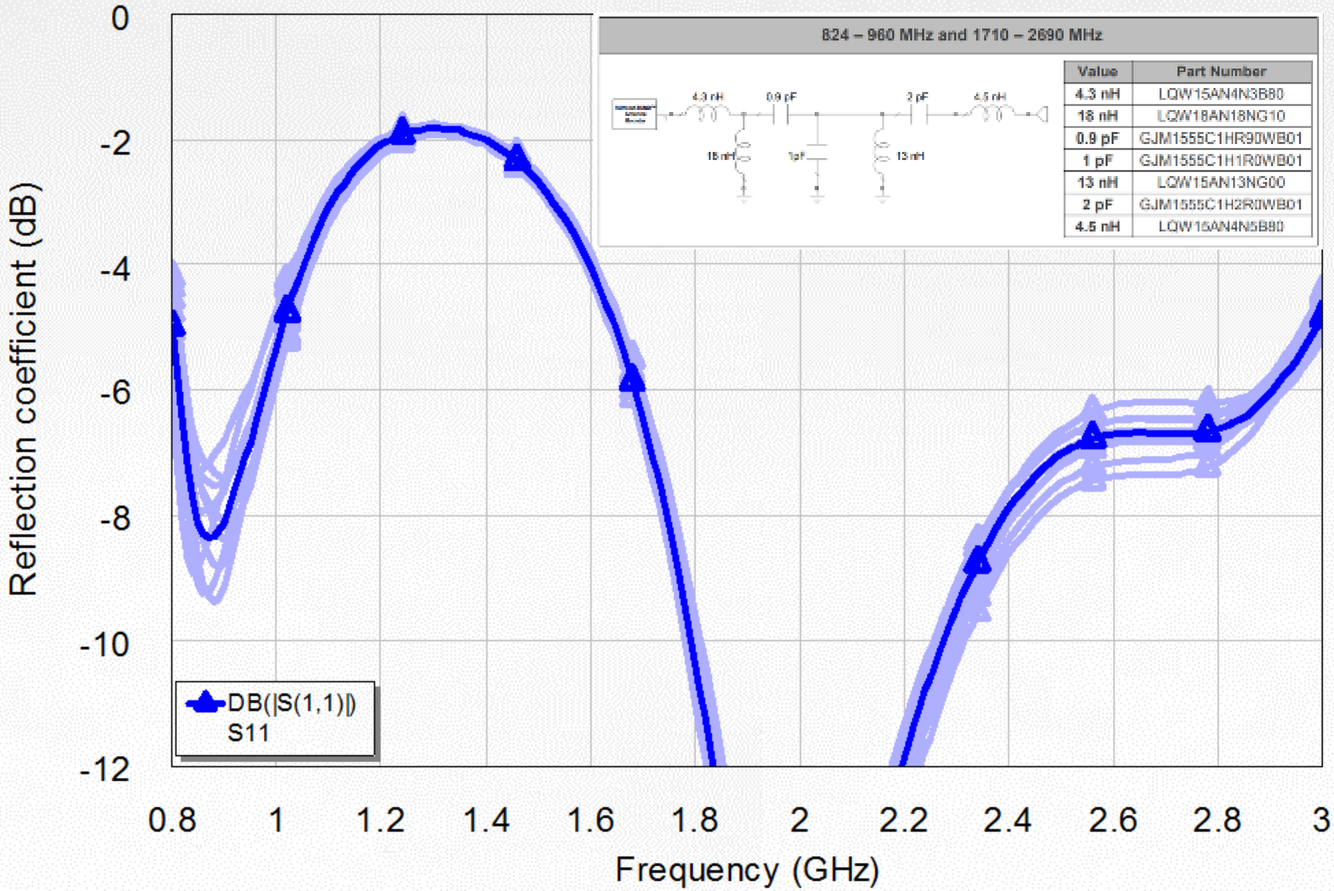
Value	Part Number
6.8 nH	LQW18AN6N8C10
15 nH	LQW18AN15NG00
0.9 pF	GJM1555C1HR90WB01
10 nH	LQW18AN10NG10
2.9 pF	GJM1555C1H2R9WB01

2G, 3G, 4G Design (1/3)



Value	Part Number
4.3 nH	LQW15AN4N3B80
18 nH	LQW18AN18NG10
0.9 pF	GJM1555C1HR90WB01
1 pF	GJM1555C1H1R0WB01
13 nH	LQW15AN13NG00
2 pF	GJM1555C1H2R0WB01
4.5 nH	LQW15AN4N5B80

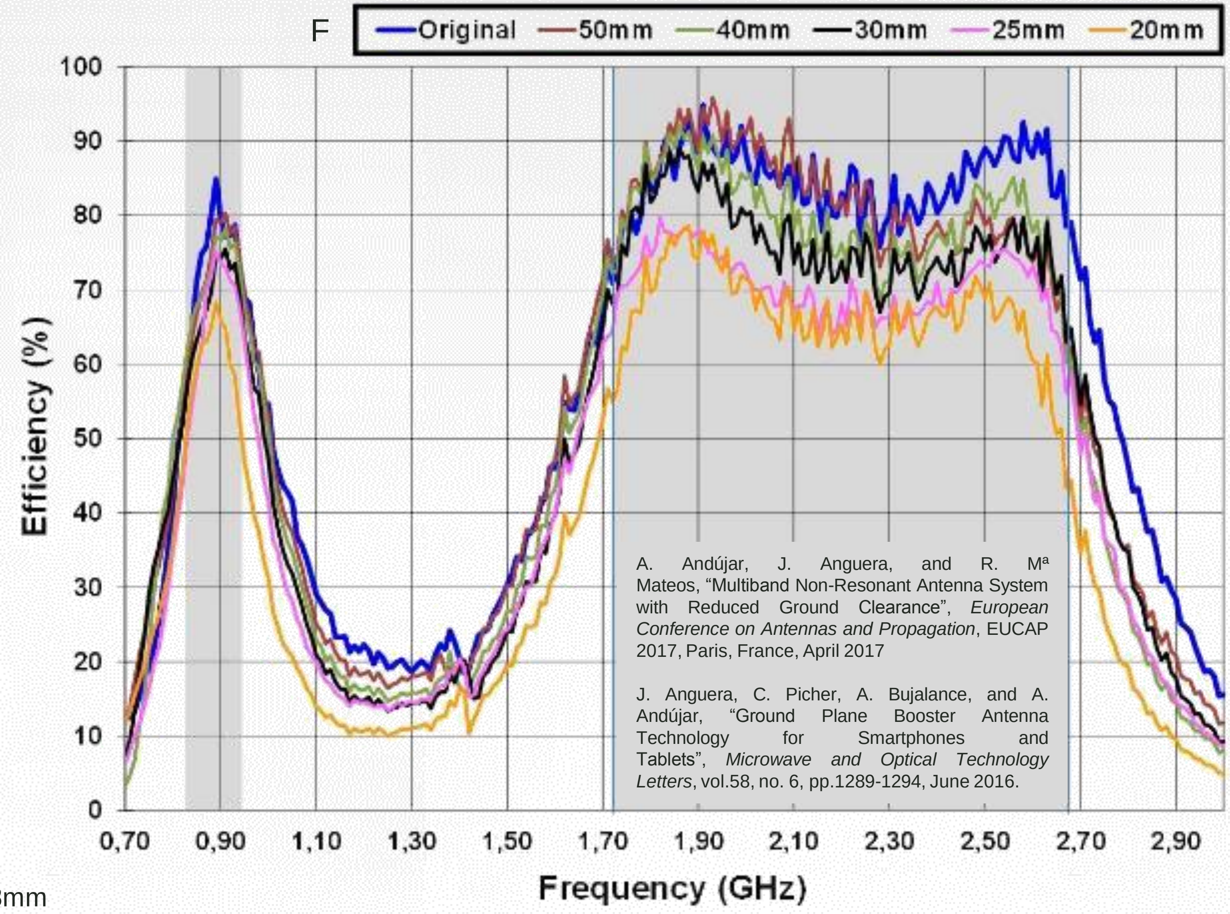
2G, 3G, 4G Design (2/3)



Value	Part Number
4.3 nH	LQW15AN4N3B80
18 nH	LQW18AN18NG10
0.9 pF	GJM1555C1HR90WB01
1 pF	GJM1555C1H1R0WB01
13 nH	LQW15AN13NG00
2 pF	GJM1555C1H2R0WB01
4.5 nH	LQW15AN4N5B80

2G, 3G, 4G Design (3/3)

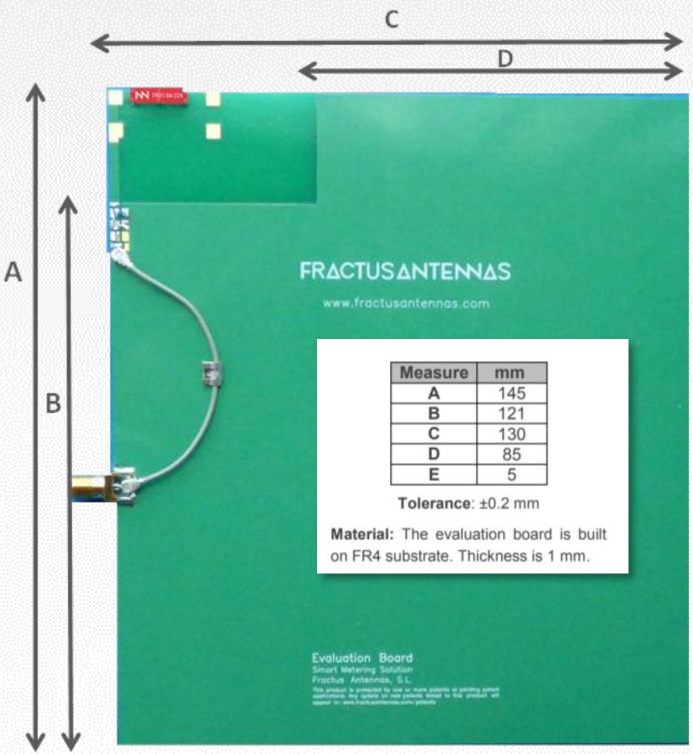
A=131mm, B=120mm, C=60mm, D=8mm



A. Andújar, J. Anguera, and R. Mª Mateos, “Multiband Non-Resonant Antenna System with Reduced Ground Clearance”, *European Conference on Antennas and Propagation*, EUCAP 2017, Paris, France, April 2017

J. Anguera, C. Picher, A. Bujalance, and A. Andújar, “Ground Plane Booster Antenna Technology for Smartphones and Tablets”, *Microwave and Optical Technology Letters*, vol.58, no. 6, pp.1289-1294, June 2016.

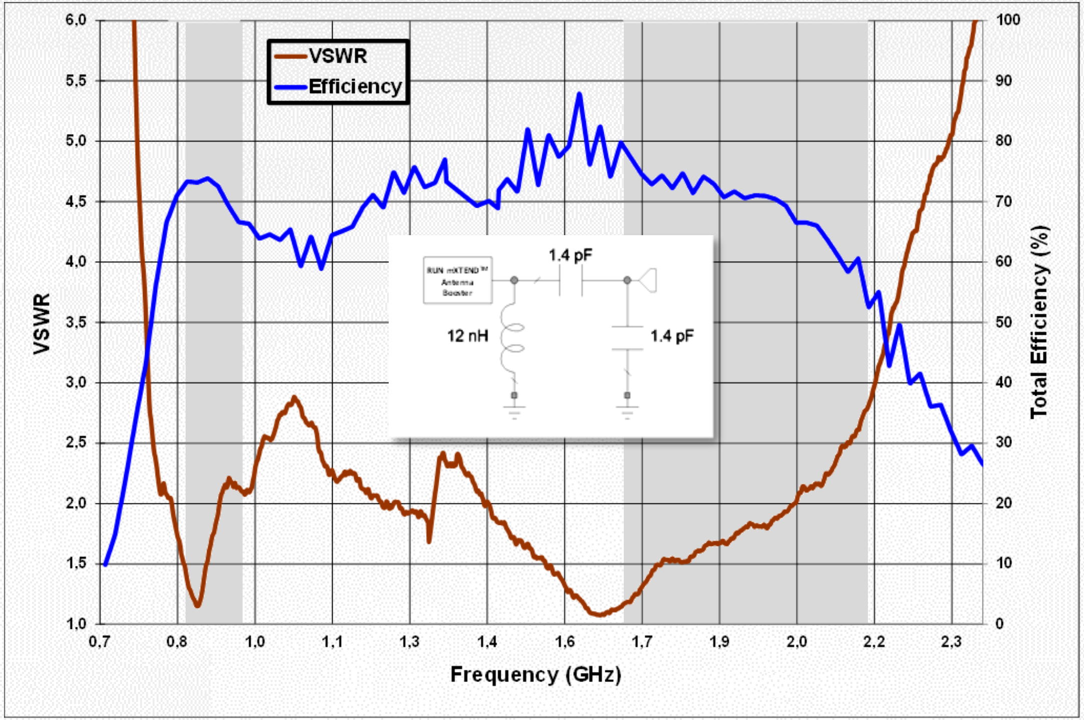
2G, 3G, 4G Design in Smart-Meters



Measure	mm
A	145
B	121
C	130
D	85
E	5

Tolerance: ±0.2 mm

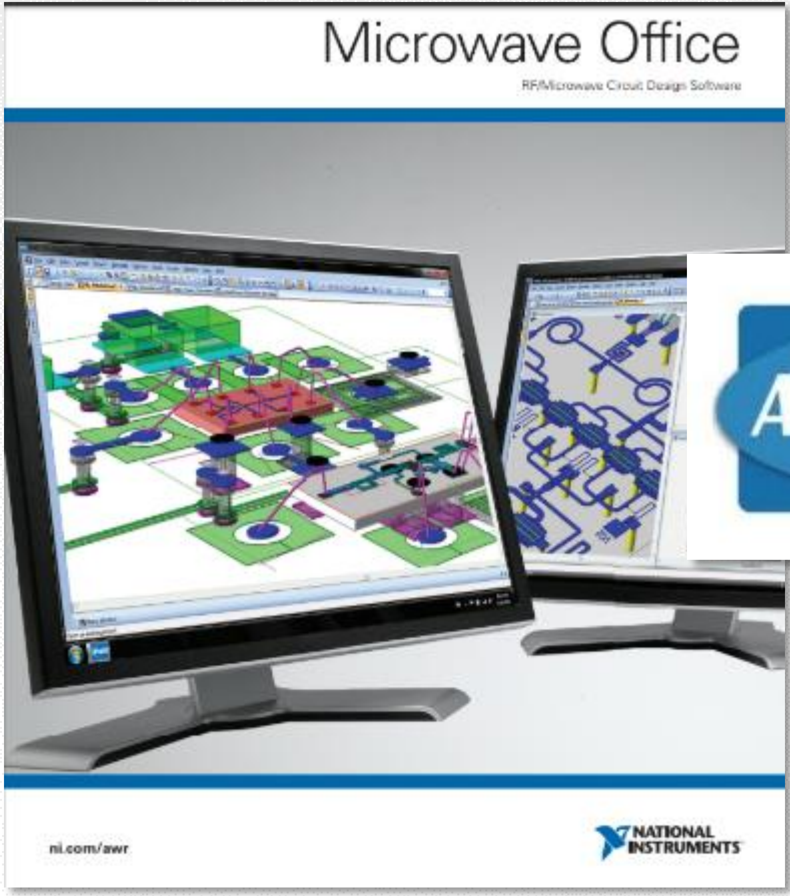
Material: The evaluation board is built on FR4 substrate. Thickness is 1 mm.



About Richardson

Coffe Break

Software Part



NI AWR Design Environment

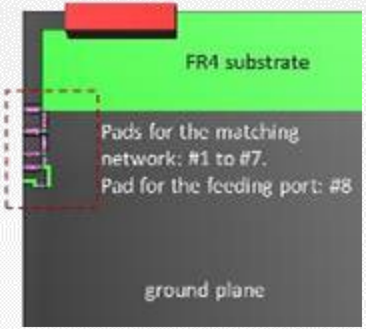
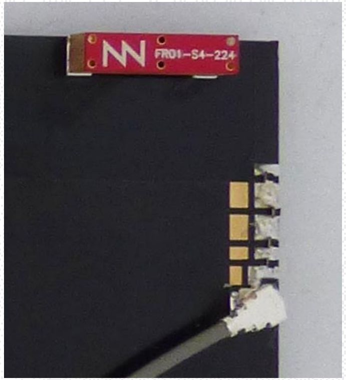
RUN mXTEND™ – 824-960MHz and 1710-2690MHz

RUN mXTEND™ (FR01-S4-224)

Note: A=131mm, B=120mm, C=60 mm

This product and its use is protected by at least one or more of the following patents and patent applications US 8,203,492; US 8,237,615; PCT/EP2013/064692; WO2014/012842; US 62/028,494; US 62/072,671; and other domestic and international patents pending. Additional information about patents related to this product is available at www.fractusantennas.com/virtual-antenna/.

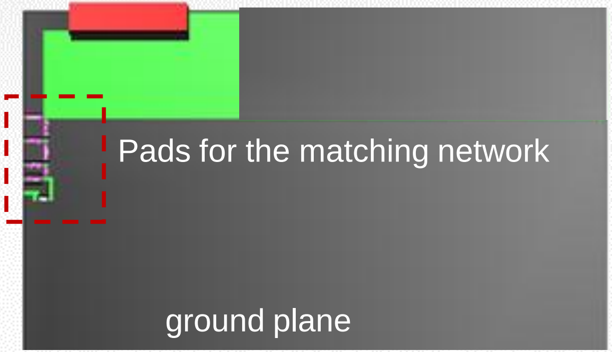
Two approaches

Full layout: Librarie[S]		Parasitic effects of pads and lumped components are taken into account. The predicted L and C values for the matching will be close to the final ones	Need a full 3D electromagnetic simulator to obtain the [S] data. Need to know the exact dimensions of the PCB, pads layout, and antenna booster to obtain the [S] data. Alternative: use Librarie[S] available at AWR Microwave Office
Single port		Parasitic effects of pads not taken into account: this may cause a deviation of the predicted L and C	A full 3D simulator is not needed. Only: - Librarie[S] or - A vector analyzer

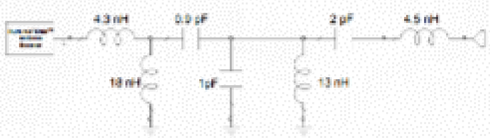
LTE Example: 824-960MHz +1710-2690MHz

Design Process with Full Layout:

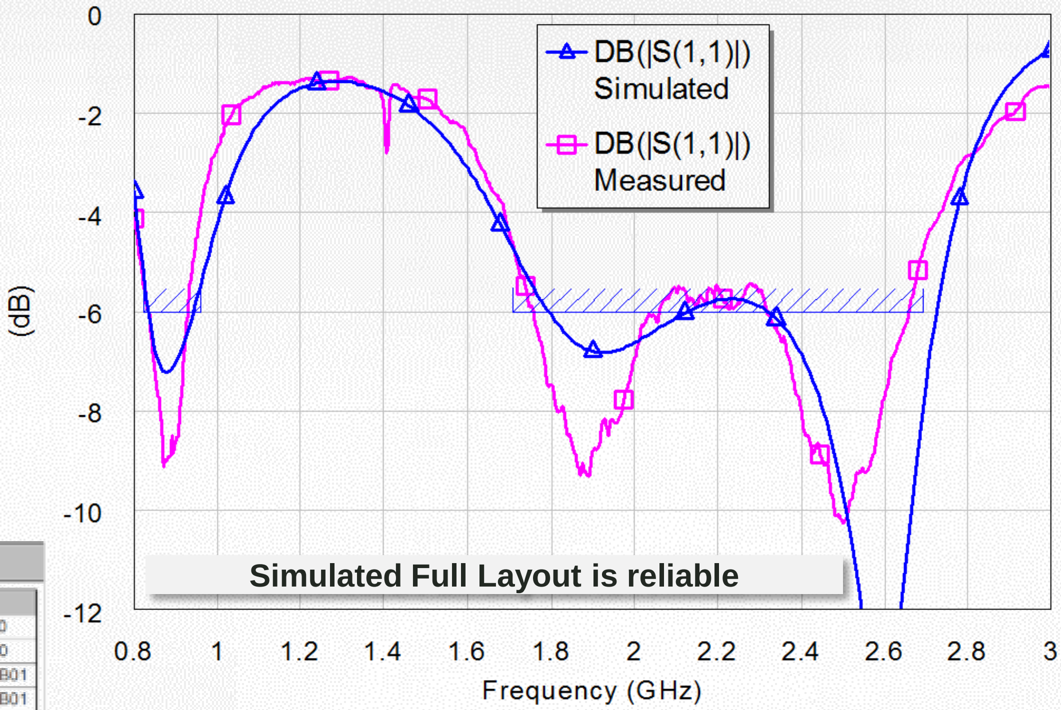
1) Full layout simulation with EM software
2) The same matching network topology as in the App Note is considered



824 – 960 MHz and 1710 – 2690 MHz



Value	Part Number
4.3 nH	LQW15AN4N3B80
18 nH	LQW18AN18NG10
0.9 pF	GJM1555C1HR90WB01
1 pF	GJM1555C1H1R0WB01
13 nH	LQW15AN13NG00
2 pF	GJM1555C1H2R0WB01
4.5 nH	LQW15AN4N5B80

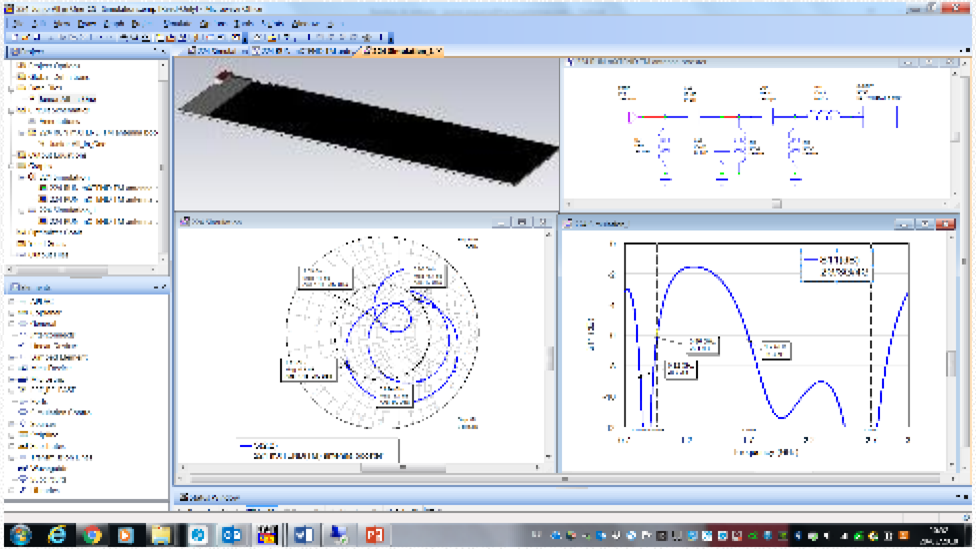


Software Part

From a [S] file corresponding to a RUN mXTEND™ antenna booster without matching network, two examples will be examined:

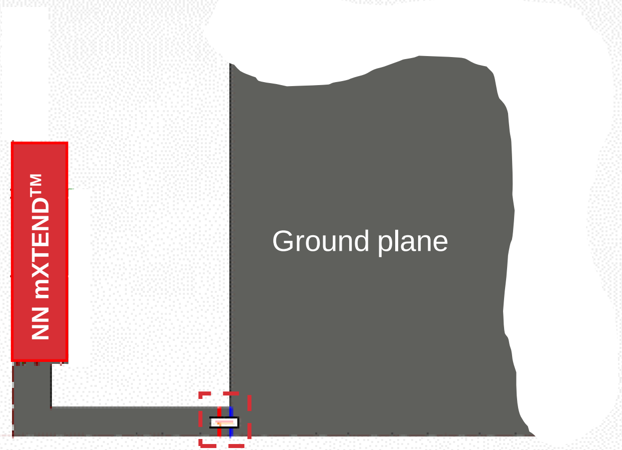
- ISM case
  1) Matching step by step with ideal components
  2) Optimization
  3) Tolerances
  4) Real components

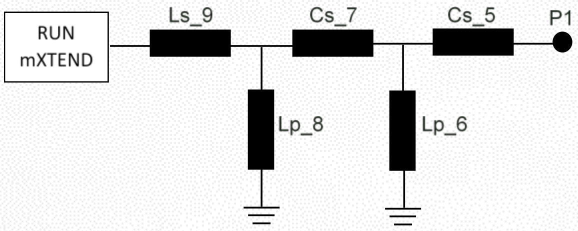
- Mobile bands
  1) Matching using Librarie-[S]



Software Part: Virtual Antenna™ Library

- [S] parameters are available at AWR Microwave Office for several platforms and with different antenna boosters. A quick-guide is also included with several examples
- Basic steps:
  - Choose the suitable platform
  - Select the antenna booster that best suits your device
  - Design the matching network with AWR Microwave Office





Please, see the information at https://www.fractusantennas.com/files/UM_Libraries.pdf

Software Part: Virtual Antenna™ Library

Application	NN mXTEND™ Antenna Component	Board Size AxC mm²	Clearance Size wxh mm²	Library File Name
Smart meter	RUN	145x130	45x24	NN_RUN_B145x130_C45x24.s9p
	ALL	145x130	45x24	NN_ALL_B145x130_C45x24.s9p
Smartphone	RUN	130x60	20x11	NN_RUN_B130x60_C20x11.s9p
Fleet Management Module	RUN	120x60	60x11	NN_RUN_B120x60_C60x11.s9p
	RUN	105x45	45x11	NN_RUN_B105x45_C45x11.s9p
	RUN	70x40	40x11	NN_RUN_B70x40_C40x11.s9p
	CUBE	120x60	60x11	NN_CUBE_B120x60_C60x11.s9p
	CUBE	105x45	45x11	NN_CUBE_B105x45_C45x11.s9p
	CUBE	70x40	40x11	NN_CUBE_B70x40_C40x11.s9p
IoT	RUN	90x90	90x11	NN_RUN_B90x90_C90x11.s9p
	RUN	90x70	70x11	NN_RUN_B90x70_C70x11.s9p
	RUN	85x55	55x11	NN_RUN_B85x55_C55x11.s9p
	RUN	70x55	55x11	NN_RUN_B70x55_C55x11.s9p
	RUN	50x55	55x11	NN_RUN_B50x55_C55x11.s9p
	RUN	50x40	40x11	NN_RUN_B50x40_C40x11.s9p
	RUN	50x20	20x11	NN_RUN_B50x20_C20x11.s9p
	CUBE	90x90	90x11	NN_CUBE_B90x90_C90x11.s9p
	CUBE	90x70	70x11	NN_CUBE_B90x70_C70x11.s9p
	CUBE	85x55	55x11	NN_CUBE_B85x55_C55x11.s9p
	CUBE	70x55	55x11	NN_CUBE_B70x55_C55x11.s9p
	CUBE	50x55	55x11	NN_CUBE_B50x55_C55x11.s9p
	CUBE	50x40	40x11	NN_CUBE_B50x40_C40x11.s9p
	CUBE	50x20	20x11	NN_CUBE_B50x20_C20x11.s9p
Wearable	RUN	30x30	14x5	NN_RUN_B30x30_C14x5.s9p
Routers/Repeates	RUN	140x120	120x11	NN_RUN_B140x120_C120x11.sp
	BAR	140x120	120x11	NN_BAR_B140x120_C120x11.sp

Table 2 – Platforms available in the NN Librarie[S].

Last update on September 2018

20 mm x 11 mm

A=130 mm
B=119 mm
C=60 mm

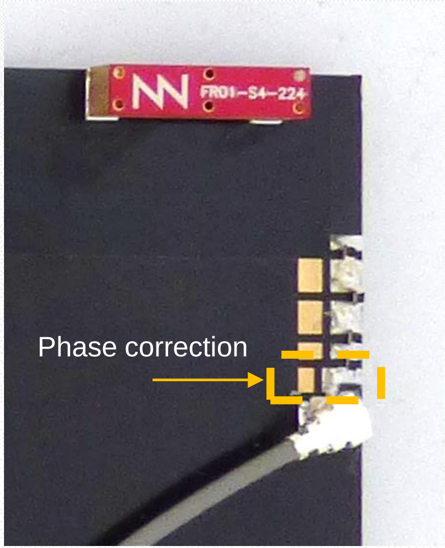
Hardware Part: Step-by-step matching process

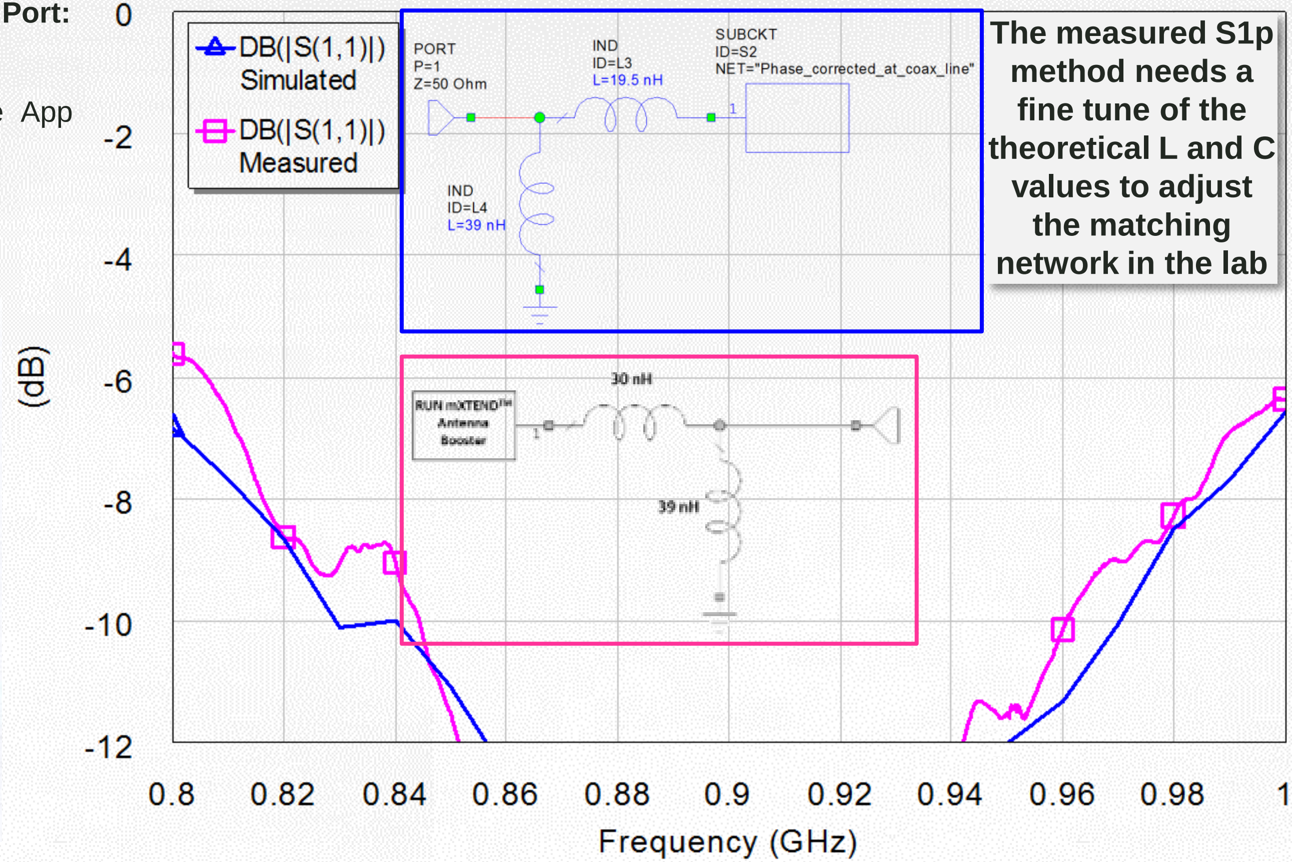
- ISM 866MHz-925MHz
- Mobile bands: 824MHz-960MHz and 1710MHz-2690MHz

ISM Example:902-928MHz

Design Process with Measured Single Port:

1) A .s1p file with phase corrected
2) The same MN topology like in the App Note is considered
3) Optimization with AWR



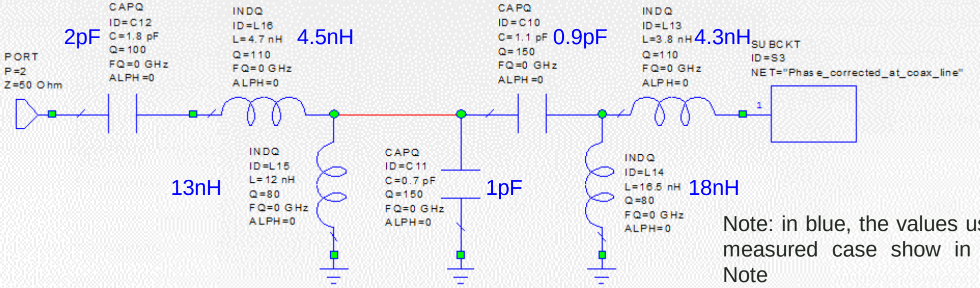


The measured S1p method needs a fine tune of the theoretical L and C values to adjust the matching network in the lab

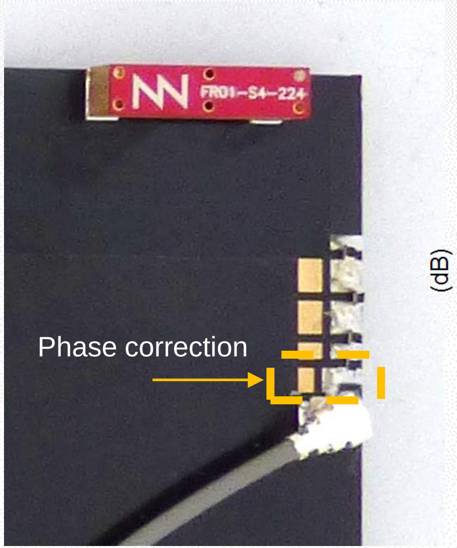
LTE Example: 824-960MHz +1710-2690MHz

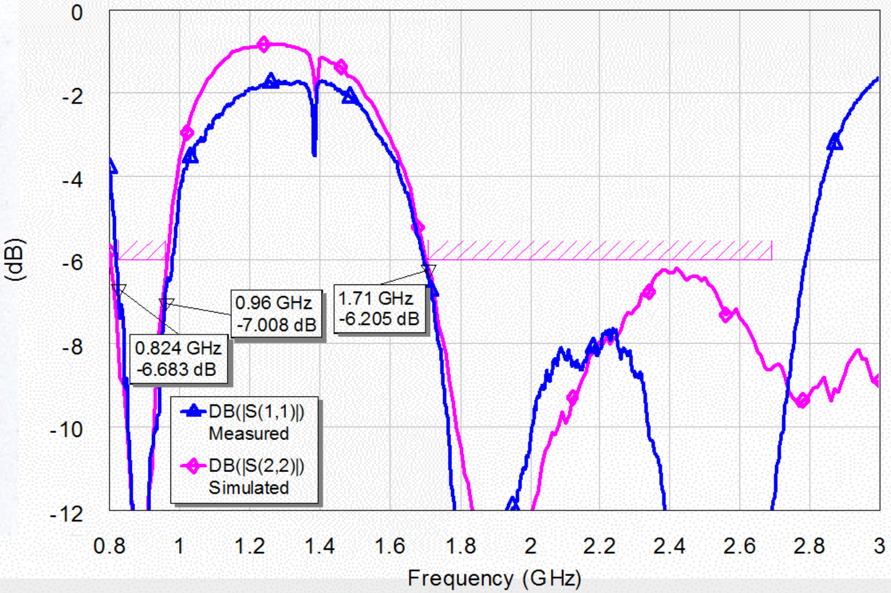
Design Process with Measured Single Port:

1) A .s1p file with phase corrected
2) The same MN topology like in the App Note is considered
3) Optimization with AWR



Note: in blue, the values used in the measured case show in the App. Note





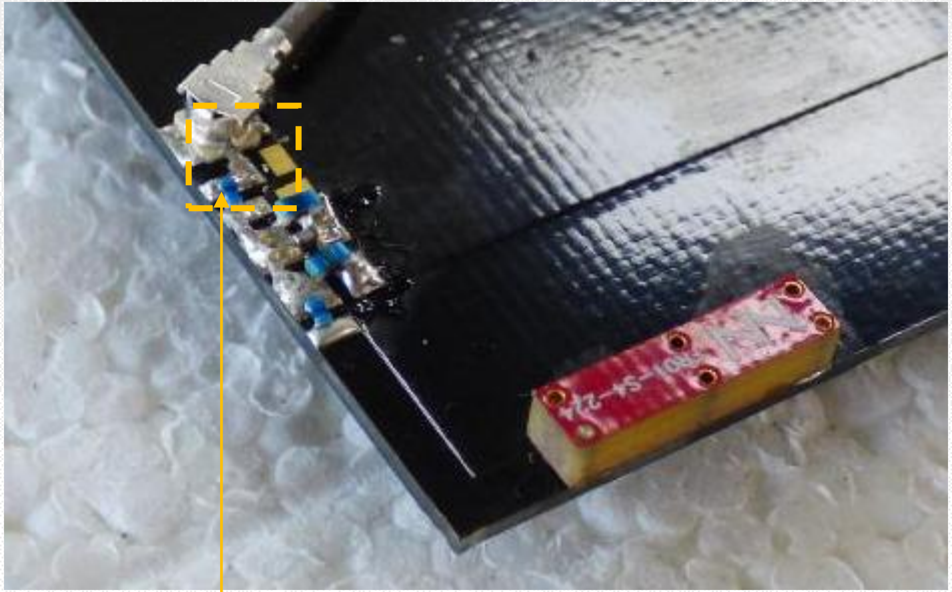
The measured S1p method needs a fine tune of the theoretical L and C values to adjust the matching network in the lab

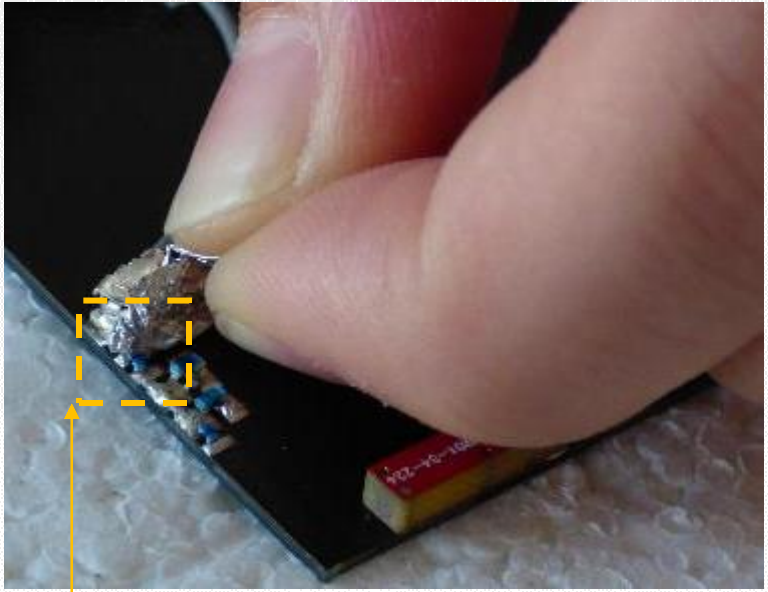
Wizard Network Synthesis: a Magic Matching

1. Select your PCB size
2. Select the suitable antenna booster
3. Define the frequency bands of operation
4. Specify the target SWR/S_{11}
5. Let the Network Synthesis of Microwave Office work for you, and…

"Get your matching network in the blink of an eye"

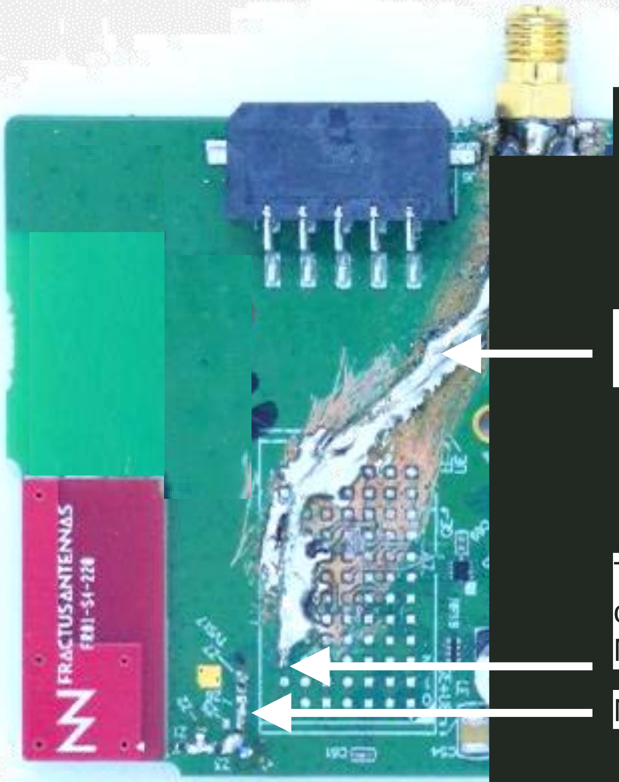
Process to correct the phase





Shortcircuit pad with GND

Practical considerations



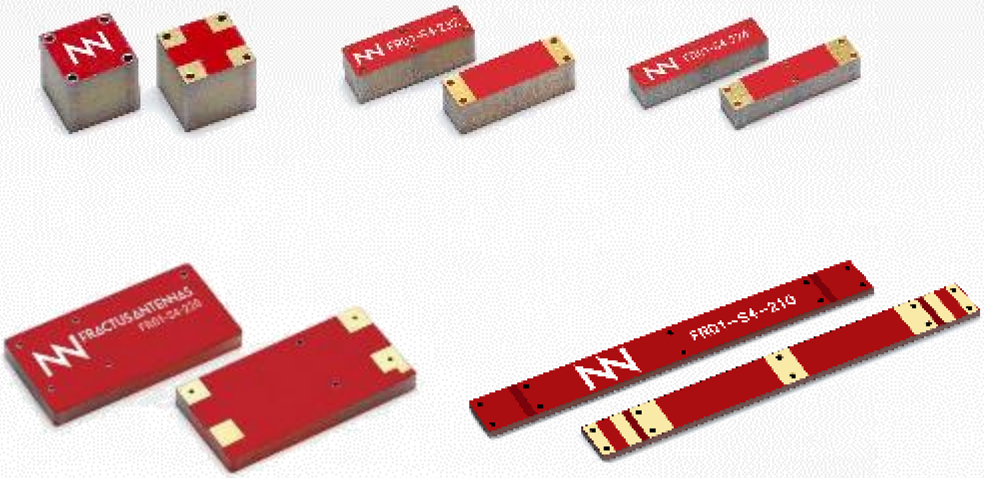
Micro-coaxial transmission line
50Ω characteristic impedance

The inner conductor of the micro-coaxial is connected at the input/output pad of the Front End Module (previously removed)

Matching network

Conclusions

- **Virtual Antenna Technology** is an **off-the-shelf antenna product**, **small**, **multi-band**, and **pick&place** (SMD component)
- Proven technology through commercial products developed by Fractus Antennas:



APPLICATIONS:
IoT
Metering (Electricity, Water,…)
Fleet-management
Modules
Routers
Smart home
Sensors (Parking, Speed Control, Optics…)
Smartphones, tablets and PCs

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FRACTUS ANTENNAS

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Electronic Design Innovation Conference
电子设计创新大会

Antenna Boosters for IoT Devices
物联网设备的天线增强器

Dr. Jaume Anguera, Chief Scientist

NI AWR Design Environment

ROHDE&SCHWARZ

RichardsonRFPD
An Arrow Company

April 2, 2019
Beijing, China